



Groundwater & Environmental Services, Inc.

6160 Fairmount Avenue, Suite A
San Diego, CA 92120

T. 866.640.4555

Via Email

February 28, 2018

Ms. Yarissa Martínez-León
Environmental Protection Agency, Region 9
Superfund Division
600 Wilshire Boulevard, Suite 940
Los Angeles, California 90017

Re: 2017 Baseline Monitoring and Aquifer Compliance Report, Dual Site Groundwater Operable Unit, Los Angeles, California

Dear Ms. Martínez-León:

Attached is the 2017 Baseline Monitoring and Aquifer Compliance Report which presents the results of the fourth baseline monitoring event completed during the period September through October 2017 for the Montrose Chemical and Del Amo Superfund Sites, Dual Site Groundwater Operable Unit located in Los Angeles, California.

Groundwater monitoring activities were conducted in accordance with the USEPA-approved Monitoring and Aquifer Compliance Plans (MACPs) prepared by each site. Data collected at other properties (i.e., Boeing, International Light Metals, Jones Chemical, and PBF Energy Refinery) has also been incorporated into this report. This report establishes groundwater conditions at the Dual Site prior to the start of the Torrance Groundwater Remediation System (TGRS) Functional Testing period.

If you have any questions regarding this report please contact Mike Palmer of *de maximis, inc.* at (619) 546-8377 or Pat Gobb of Newfields at (972) 956-9100.

Sincerely,

A handwritten signature in black ink, appearing to read 'Tom Wright', with a stylized flourish at the end.

Tom Wright, PG 7972, CHg 980
Groundwater and Environmental Services, Inc.

cc: Joe Kelly, Montrose Chemical Corporation of California-Electronic Copy
Kelly Richardson, Esq., Latham & Watkins-Electronic Copy
Carol Campagna, Shell-Electronic Copy
Pat Gobb, Newfields-Electronic Copy
Willard Garrett, DTSC-Hard Copy
James Teo, APTIM-Hard Copy

2017 BASELINE MONITORING AND AQUIFER COMPLIANCE REPORT

Montrose Chemical and Del Amo Superfund Sites,
Dual Site Groundwater Operable Unit
Los Angeles, California

Submitted: February 28, 2018

Prepared For:

Montrose Chemical Corporation of California

AND

Shell Oil Company

Prepared By:

AECOM
130 Robin Hill Road, Suite 100
Santa Barbara, California 93117

NewFields
2850 Lake Vista Drive, Suite 140
Lewisville, Texas 75067

AND

Groundwater & Environmental Services, Inc.
6160 Fairmount Avenue, Suite A
San Diego, California 92120

ddms
1217 Bandana Boulevard
Saint Paul, Minnesota 55108

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ACRONYMS AND ABBREVIATIONS

µg/L	Micrograms per liter
ADPA	Anti-Degradation Policy Analysis
bgs	Below ground surface
BRA	Baseline Risk Assessment
CH ₄	Dissolved Methane
CO ₂	Carbon dioxide
COC	Chemical of Concern
CPA	Central Process Area
CPT	Cone penetrometer
CSM	Conceptual Site Model
DDT	Dichlorodiphenyltrichloroethane
DNAPL	Dense Non-Aqueous Phase Liquid
DO	Dissolved oxygen
Dual Site	Dual Site Groundwater Operable Unit
FS	Feasibility Study
Fe ²⁺	Ferrous iron
Fe ³⁺	Ferric iron
GWSDAT	Groundwater Spatio-Temporal Data Analysis Tool
HSU	Hydrostratigraphic unit
ILM	International Light Metals
IRM	Instantaneous reaction model
ISGS	<i>In-Situ</i> Groundwater Standards
J	Indicates estimated laboratory analytical result
JCI	Jones Chemical, Inc.
L	Liter
LBF	Lower Bellflower Aquitard
LCS	Laboratory Control Samples
MACP	Monitoring and Aquifer Compliance Plan
MACR	Monitoring and Aquifer Compliance Report
MBF	Middle Bellflower
MBFB	Middle Bellflower B Sand
MBFC	Middle Bellflower C Sand
MBFM	Middle Bellflower Mud
MBT	Molecular Biological Tools
MCL	Maximum Contaminant Level
mL	Milliliter
Montrose	Montrose Chemical Corporation of California
MS/MSD	Matrix Spike/Matrix Spike Duplicate
msl	Mean Sea Level

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NAPL	Non-aqueous Phase Liquid
NAVD	North American Vertical Datum
ND	Not detected at the indicated reporting limit
NGVD	National Geodetic Vertical Datum
NO ₃ ⁻	Nitrate
NTU	Nephelometric Turbidity Unit
O&M	Operation and Maintenance
OOM	Orders of magnitude
ORP	Oxidation-reduction potential
OU	Operable Unit
PBF	PBF Energy
pCBSA	Para-Chlorobenzene Sulfonic Acid
PCE	Tetrachloroethene
QA/QC	Quality Assurance/Quality Control
qPCR	Quantitative Polymerase Chain Reaction
RAO	Remedial Action Objectives
RI	Remedial Investigation
ROD	Record of Decision
RPD	Relative percent difference
SIM	Single Ion Method
SO ₄ ²⁻	Sulfate
SVE	Soil vapor extraction
TBA	Tert-butyl alcohol
TCE	Trichloroethene
TGRS	Torrance Groundwater Remediation System
TI	Technical Impracticability
U	Not detected at the indicated reporting limit
UBF	Upper Bellflower Aquitard
USEPA	United States Environmental Protection Agency
VOC	Volatile organic compound

EXECUTIVE SUMMARY

This Monitoring and Aquifer Compliance Report (MACR) presents the results of the 2017 groundwater monitoring event completed from September through October 2017, for the Montrose Chemical Corporation of California (Montrose) and Del Amo Superfund Sites, Dual Site Groundwater Operable Unit (OU) located in Los Angeles, California (Dual Site). The groundwater monitoring event was conducted in accordance with United States Environmental Protection Agency (USEPA)-approved Monitoring and Aquifer Compliance Plans (MACPs) prepared by each party.

This 2017 groundwater monitoring event focused on the measurement of groundwater levels and the collection of groundwater samples for laboratory analysis. Analytical data collected by other parties for properties located in the vicinity of the Dual Site, including Boeing; International Light Metals (ILM); and Jones Chemical, Inc. (JCI) have also been incorporated into this report. In addition, groundwater elevation data collected for the Honeywell and PBF Energy sites are included.

The horizontal and vertical hydraulic gradients remain generally consistent with the prior baseline monitoring event in 2016. The overall extent of Dual Site chemicals is generally consistent with the prior baseline event conducted in 2016. Multiple lines of evidence show that benzene biodegradation continues to occur and is sufficient to contain the plume in the water table and Middle Bellflower B sand (MBFB) / Merged MBFB/Middle Bellflower C sand (MBFC) units. Since biodegradation of benzene is occurring in the water table and MBFB / Merged MBFB/MBFC units, it is likely or probable that biodegradation of benzene also occurs in the Gage Aquifer.

Continued monitoring of the Dual Site monitoring network wells in accordance with approved MACPs prepared by each party is recommended.

1 INTRODUCTION AND CONCEPTUAL SITE MODEL

This Monitoring and Aquifer Compliance Report (MACR) presents results of the 2017 baseline groundwater monitoring event for the Montrose Chemical Corporation of California (Montrose) and Del Amo Superfund Sites, Dual Site (Dual Site) Groundwater Operable Unit (OU). The monitoring event was conducted by Montrose and Shell Oil Company at the request of the United States Environmental Protection Agency (USEPA), in accordance with individual Montrose and Del Amo Site Monitoring and Aquifer Compliance Plans (MACPs; AECOM, 2014; URS, 2014) as well as the USEPA-approved 2017 Sampling and Analytical Plan (AECOM, 2017b).

While this MACR is produced by the Montrose and Del Amo parties, additional data collected by other parties for environmentally impacted sites located in the vicinity of the Dual Site have been incorporated to allow presentation of a more regional interpretation of groundwater conditions. These additional sites include existing or former facilities operated by Boeing; Jones Chemical, Inc. (JCI); Honeywell Site B (Honeywell; groundwater elevation data only); International Light Metals (ILM); and PBF Energy (PBF; former ExxonMobil Refinery; groundwater elevation data only). Data provided by these parties has not been validated, but is presented for informational purposes, per USEPA direction.

The Decision Summary section of USEPA's Record of Decision for the Dual Site (ROD; USEPA 1999) defines the Dual Site chlorobenzene, benzene, and trichloroethene (TCE) plumes, and establishes remedial requirements and objectives for each. The purpose of the annual monitoring program is to collect reliable and sufficient groundwater data for monitoring remedy performance and demonstrating compliance with the ROD objectives, as summarized in Table 1. The 2017 monitoring event generated data by which groundwater levels and flow, and the extent of Dual Site chemical plumes, as well as para-chlorobenzene sulfonic acid (pCBSA), tetrachloroethene (PCE), and tert-butyl alcohol (TBA) plumes, were evaluated. Benzene biodegradation was also evaluated. The monitoring event included the following tasks:

- Measurement of groundwater elevation in 505 wells;
- Collection and laboratory analysis of groundwater samples from 315 wells; and
- Evaluation and reporting of the findings.

Details regarding the above tasks are presented in Sections 2 and 3.

The remainder of this section comprises the Conceptual Site Model (CSM), presenting background information regarding the location and physical setting of the Dual Site, the chemicals of concern (COCs), source areas, and potential exposure pathways and receptors. The CSM is an evergreen document that will be updated as required when new information is obtained.

1.1 LOCATION AND LAND USE

The location of the Dual Site is shown on Figure 1. Additional information specific to the individual sites is presented below.

1.1.1 Montrose Chemical Superfund Site

The Montrose Site is located at 20201 South Normandie Avenue in the City of Los Angeles (Figure 1). The Montrose Site occupies approximately 13 acres located within the Harbor Gateway, which extends from Western Avenue to Normandie Avenue. Torrance and unincorporated Los Angeles County are located west and east, respectively, of the Harbor Gateway. Montrose manufactured technical-grade dichlorodiphenyltrichloroethane (DDT) at their facility from 1947 to 1982.

1.1.2 Del Amo Superfund Site

The Del Amo Site is located at the southwest corner of the intersection of the 405 and 110 freeways in the Harbor Gateway area, adjacent to the cities of Torrance to the west and Carson to the east. The Del Amo Site comprises approximately 280 acres that were formerly occupied by a synthetic rubber plant but are now developed as a business park, including numerous industrial/commercial buildings and associated parking lots on 83 parcels. Parcels located within the Del Amo Site are zoned for heavy or light manufacturing/industrial use, excepting one parcel that is designated for commercial use and two parcels that are part of a utility corridor and zoned as public facilities. The anticipated future land use at the site is the same as the current land use. Land use adjacent to the Del Amo Site is light industrial and residential to the north; industrial and commercial to the east; residential, industrial, and commercial to the south; and industrial and commercial to the west. Del Amo Site parcel boundaries and land use in the vicinity of the Del Amo Site are shown on Figure 2.

1.1.3 Other Environmental Sites

The Dual Site is surrounded by other industrial sites that have contributed to groundwater impacts in the vicinity, shown on Figure 1. Data from the sites listed below are included in this MACR.

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Facility	Location	Groundwater Impacts
Boeing	North of Montrose	Chlorinated volatile organic compounds (VOCs), primarily TCE
Trico/PACCAR	West of Del Amo	Chlorinated VOCs, primarily TCE
Amoco Chemical (American Polystyrene)	West of Del Amo	Chlorinated VOCs, primarily TCE
ILM	Northwest of Montrose	Chlorinated VOCs, primarily TCE
Honeywell Site B	West of Montrose	1,1,1-Trichloroethane, 1,1-Dichloroethene, PCE and TCE
JCI	South of Montrose	PCE, TCE
PBF (previously ExxonMobil)	West of Montrose	VOCs, primarily benzene

Additional source areas are addressed in Section 1.7.

1.2 SITE HISTORY

1.2.1 Montrose Site

The Montrose Site was undeveloped land until the early 1930s. In 1943, Stauffer Chemical Company (Stauffer) purchased the property (and adjacent land). In 1947, Stauffer leased portions of the property to Montrose. Montrose manufactured technical-grade DDT at the property from 1947 until 1982. Most operations took place in the Central Process Area (CPA) where monochlorobenzene and chloral were combined in the presence of a strong sulfuric acid catalyst (oleum) to make DDT. After ceasing facility operations in 1982, the plant was fully dismantled and demolished by early 1983. In 1984 and 1985, Montrose graded and covered most of the property with asphalt.

1.2.2 Del Amo Site

The Del Amo Site was formerly occupied by a synthetic rubber plant. The plant was constructed in 1942 by the U.S. government in support of World War II activities, and included styrene, butadiene, and copolymer planters. Styrene and butadiene were synthesized in their respective planters and then combined in the copolymer planter to produce synthetic rubber. Other chemicals stored and used in the process as either feedstock or intermediary products included benzene, ethylbenzene, propane, butylene, butane, and lesser amounts of other chemicals. Ownership of the plant was transferred from the U.S. government to Shell Chemical in 1955 and the plant continued to operate until 1972 when it was decommissioned and sold to a land development company. The Del Amo Site was subsequently subdivided and gradually redeveloped into the current business park. The location of former rubber plant facilities in relation to current buildings and streets is depicted on Figure 3.

1.3 REGULATORY FRAMEWORK

Key regulatory dates and milestones for the Dual Site are indicated in the table below:

Date	Event
1982	Environmental investigation of Del Amo Site initiated (Western Waste and Department of Health Services/California Department of Toxic Substances Control)
1992	Administrative order on consent for Del Amo Remedial Investigation (RI)/Feasibility Study (FS) and Focused Feasibility Study issued (USEPA)
1985 to 2010	Montrose groundwater investigation (Various)
1985 to present	Montrose groundwater monitoring events (Various)
1992–1993	Initial Del Amo groundwater investigations completed (Dames & Moore)
1994–2012	Del Amo groundwater monitoring events (Dames & Moore/URS)
1995	Del Amo Site differentiated into separate operable units, including the Dual Site Groundwater Operable Unit (USEPA)
March 1996	Dual Site groundwater flow modeling begun (USEPA)
May 1998	Final RI Report for the Montrose Superfund Site submitted (USEPA)
February 1998	Joint Site Groundwater Risk Assessment report issued (McLaren Hart)
May 1998	Del Amo Groundwater RI Report issued (Dames & Moore); Joint Site Groundwater FS Report issued (USEPA)
March 1999	Dual Site Groundwater ROD issued (USEPA)
2002	Del Amo Site added to National Priorities List (USEPA)
2003	Unilateral administrative orders issued for Initial Remedial Design Work (USEPA; separate orders for Del Amo and Montrose parties)
March 2007	Completion Report for: TCE Plume Data Acquisition DSGWRD26-002; para-Chlorobenzene Sulfonic Acid Data Acquisition DSGWRD 26-005; and Additional Monitor Wells for Model Refinement DSGWRD26-002, Montrose Site, Torrance, California (Hargis+Associates) submitted
June 2007	Combined 2006 Baseline Groundwater Monitoring/TCE and Benzene Plumes Data Acquisition Report for Del Amo Site issued (URS)
May 2008	Amended unilateral administrative order issued for Remedial Design Work (single order issued to both Montrose and Del Amo parties)
September 2008	Model Development and Remedial Wellfield Optimization Report for Dual Site issued (USEPA/CH2MHill)
August 2012	Construction Partial Consent Decree issued to construct the groundwater treatment system as specified in the 1999 ROD (USEPA)
July 2014	MACP voluntarily completed for Montrose Site (AECOM; no associated USEPA order in place)
September 2014	MACP voluntarily completed for Del Amo Site (URS; no associated USEPA order in place)

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Date	Event
December 2014	USEPA notified Montrose on December 19, 2014 that Montrose was not permitted to initiate the five-day testing as outlined in the Construction Performance Evaluation Test Workplan. USEPA's refusal to allow Montrose to complete the work required by the Partial Consent Decree, and the State's involvement in that decision, was not supported under the Consent Decree or otherwise
January 2015	USEPA withdrew approval for Remedial Wellfield Treatment System Performance Evaluation Test Plan, preventing its operation
February 2015	Montrose filed a Notice of Dispute under the Partial Consent Decree, arguing that USEPA unlawfully withdrew its approval for Montrose to implement the work required by the Consent Decree. On February 27, Montrose subsequently filed a Statement of Position on initiating the formal dispute resolution process under the Consent Decree
February 2015	Montrose notified USEPA and the State that their actions are directly responsible for preventing the startup of the groundwater treatment system and could result in further migration of the groundwater plume and related consequences, including vapor intrusion impacts
February 2015	2014 MACR voluntarily completed for Del Amo Site (URS; no associated USEPA order in place)
March 2015	2014 MACR voluntarily completed for Montrose Site (AECOM; no associated USEPA order in place)
April 2015	Montrose submitted reply to USEPA Statement on Position (April 3, 2015).
May 2015 to present	Montrose and USEPA confidential settlement meetings
March 2016	2015 Dual Site MACR voluntarily completed for Montrose and Del Amo sites (no associated USEPA order in place)
March 2017	2016 Dual Site MACR voluntarily completed for Montrose and Del Amo sites (no associated USEPA order in place)

1.3.1 Groundwater Remedy

The ROD specifies hydraulic extraction and monitored intrinsic biodegradation as the Dual Site groundwater remedy. Hydraulic extraction will principally treat the chlorobenzene plume and partially contain TCE sources upgradient from the Dual Site. Implementation of the hydraulic extraction portion of the remedy to date has consisted of construction of the Torrance Groundwater Remediation System (TGRS) and the start of TGRS functional testing. Data associated with this MACR was collected prior to the start of TGRS functional testing. The system includes 11 extraction wells, seven injection wells, a water treatment system, and associated pipeline conveyance system, as depicted on Figure 4.

Extraction wells are located in the water table (two wells); soils described in Section 1.5 and known as the Merged Middle Bellflower B/ Middle Bellflower C (Merged MBFB/MBFC) (three wells), MBFC (two wells), and the Gage Aquifer (four wells). Injection is planned to occur in the Gage Aquifer. Extracted groundwater will be treated to remove dissolved VOCs and pCBSA, and will comply with *in-situ* groundwater standards (ISGS) and injection standards as outlined in the ROD (USEPA, 1999). The treatment train utilizes a combination of advanced oxidation (HiPOx™), air stripping, carbon adsorption, and filtration. The TGRS is expected to operate for 30 to 50 years to reduce concentrations to ISGS levels in water-bearing units outside the technical impracticability waiver zone (TI Waiver Zone). Phase 2 functional testing of the TGRS performed in November 2015 demonstrated that the TGRS can meet ISGS and injection standards. A 90-day functional test was initiated on December 5, 2017 and the results of this testing will be reported under separate cover. Since the design was completed and the TGRS was constructed, EPA has completed an Anti-Degradation Policy Analysis (ADPA [USEPA, 2017a]). Montrose opposes the application of the ADPA to the Dual Site. Discussion of the applicability of the ADPA to Montrose's groundwater remedy is ongoing with USEPA.

The benzene plume remedy is monitored intrinsic biodegradation. Intrinsic biodegradation refers to the metabolism and breakdown of chemicals by naturally occurring microbes. Evidence that intrinsic biodegradation of benzene is occurring is provided through numerous lines of evidence, including the spatial distribution of the plume through time and various geochemical and microbiological indicators, as evaluated in Section 3.4. The current groundwater monitoring program provides for continued evaluation of biodegradation.

Remedies for non-aqueous phase liquid (NAPL) source areas impacting groundwater include soil heating/soil vapor extraction (SVE) for the Montrose Site and in-situ chemical oxidation and SVE for the Del Amo Soil and NAPL OU (USEPA, 2013, 2014). Implementation of the Del Amo NAPL remedy will occur after completion of current Soil and NAPL OU remedial design investigations.

In accordance with the ROD, TCE will be addressed by the TCE Parties at a later date using hydraulic extraction near the source areas to partially contain the TCE plume. Extraction wells are currently operating at Boeing, addressing TCE source areas at that Site, separate from the Dual Site remedy.

1.3.2 Remedial Goals

The Dual Site ROD (USEPA, 1999) outlines applicable ISGS and remedial action objectives (RAO). ISGS are compound-specific concentrations that must be attained in groundwater through the ROD-selected remedial action. For the Dual Site, the ISGS are the more stringent of the federal and state drinking water maximum contaminant levels (MCLs). For compounds for which neither a federal nor a state MCL is promulgated, ISGS are the USEPA Region IX tap water Preliminary

Risk Goals (now referred to as Regional Screening Levels). ISGS for the driving chemicals at the Dual Site, as identified in Table 9-1 of the ROD, are as follows:

- Chlorobenzene: 70 micrograms per liter (µg/L);
- Benzene: 1 µg/L;
- TCE: 5 µg/L; and
- PCE: 5 µg/L.

Groundwater RAOs for the Dual Site are:

1. Where technically practicable, reduce concentrations to ISGS levels;
2. In areas of groundwater where attainment of ISGS levels is not technically practicable, contain constituents within their current lateral extent and depth;
3. Isolate NAPL by surrounding it with a zone of groundwater from which dissolved-phase constituents cannot escape;
4. Prevent lateral and vertical migration of dissolved-phase constituents at concentrations greater than ISGS levels to areas where currently they are not present or are below ISGS levels, and
5. Protect current and future users of groundwater from exposure to concentrations above ISGS levels.

The ROD further established a TI Waiver Zone for four hydrostratigraphic units (HSUs) and coincident containment zones for those areas where groundwater cannot be restored to ISGS levels (Figure 5). These zones represent a region of dissolved-phase chemicals surrounding and isolating NAPL, within which restoration to ISGS levels is regarded as technically impracticable. The RAO for groundwater inside the zone is containment while the objective for groundwater outside the containment zone is restoration to ISGS levels.

1.4 PHYSIOGRAPHY AND GEOLOGICAL SETTING

The Dual Site lies in the Torrance Plain, a relatively flat, low-lying area within the larger coastal plain of the greater Los Angeles area. The Torrance Plain is wedge-shaped, opening to the southeast, and bounded by the Rosecrans Hills and Dominguez Hills to the northeast, the El Segundo Sand Hills and Palos Verdes Hills to the southwest, and San Pedro Bay to the southeast (Figure 7). The Rosecrans and Dominguez hills are local manifestations of the Newport-Inglewood structural zone, a faulted anticlinal belt that transects the coastal plain in a northwest-southeast direction, extending from Beverly Hills in the north to Seal Beach in the south. The Dual Site is positioned along the southwest limb of the Gardena Syncline so that underlying stratigraphic units dip slightly to the northeast (CDWR, 1961).

1.5 HYDROSTRATIGRAPHY

The Dual Site overlies the West Coast Groundwater Basin, a sub-basin of the Los Angeles Coastal Groundwater Basin (Figure 6). The West Coast Basin is underlain by a sequence of middle Miocene- through Holocene-age marine and continental sediments up to 13,000 feet thick. Water-bearing sediments underlying the Dual Site include marine and continental deposits of the lower Pleistocene San Pedro Formation and the overlying, upper Pleistocene Lakewood Formation. These formations consist of sand or silty sand aquifers separated by silt and clay aquitards and have a cumulative thickness of greater than 800 feet in the vicinity of the Dual Site. A long-term trend of rising groundwater levels at the Dual Site is evident from the hydrograph presented on Figure 7. The trend of rising groundwater elevations began in 1965 and is inferred to be associated with adjudication of the West Coast Basin that occurred in 1961 (Dames & Moore, 1998).

The Dual Site HSUs and their spatial relationships are presented on Figure 8 (block diagram) and are further described below. Representative cross sections as well as isopach maps showing the interpreted HSU positions are presented in Appendix A (Dames & Moore, 1998; USEPA, 1998).

1.5.1 Lakewood Formation

The Lakewood Formation includes the Bellflower Aquitard and underlying Gage Aquifer. The Bellflower Aquitard is subdivided into the Upper Bellflower Aquitard (UBF), the Middle Bellflower (MBF), and the Lower Bellflower Aquitard (LBF) based on the predominance of muddy or sandy lithotypes, as described below.

1.5.1.1 *Upper Bellflower Aquitard*

The UBF is the uppermost water-bearing unit at the Montrose Site and at the central and eastern portions of the Del Amo Site. The UBF ranges from 41 to 97 feet thick at the Del Amo Site but thickens at the Montrose Site, where its base occurs at depths up to approximately 105 feet below ground surface (bgs). The saturated portion of the UBF is heterogeneous and consists of interbedded olive-brown, fine-grained sands and muds of varying thicknesses and lateral continuity. Sand layers within the saturated UBF typically range from less than one to ten feet thick and tend to be discontinuous, with the exception of a transitional silty sand layer at the base of the UBF at the Montrose Site. The finer-grained muds within the saturated UBF are up to 30 feet thick and generally continuous at the Del Amo Site, but are less than one to ten feet thick and discontinuous at the Montrose Site.

1.5.1.2 *Middle Bellflower*

The Middle Bellflower underlies the UBF and is a light yellowish brown, fine to medium-grained sand that is between 20 and 65 feet thick with local muddy zones. A mud layer is present within the Middle Bellflower in the western portion of the Del Amo Site, but thins rapidly to the east and

is absent in the central and eastern portions of the Del Amo Site. Where present, the mud divides the Middle Bellflower into three members, identified from shallowest to deepest as the MBFB, the Middle Bellflower mud (MBFM), and the MBFC. The MBFB is generally an olive-colored fine-grained sand, with a localized muddy layer and an average thickness of approximately 15 feet. The MBFM consists of laminated silts and very fine-grained sands that pinch out to the east and have an average thickness of approximately seven feet. The MBFC is a thick body of fine to medium-grained sand with local muddy layers and lenses that vary from nine to 60 feet thick. A distinctive coarsening sand with shell fragments characterizes the base of the unit.

The Middle Bellflower is not segregated into subunits in the central and eastern portions of the Del Amo Site where the MBFM is absent, and forms a virtually uninterrupted sand unit with inferred greater hydraulic interconnection relative to areas where the mud is present. This portion of the Middle Bellflower is referred to as the Merged MBFB/MBFC. At the Montrose Site, the MBFC directly underlies the UBF where the MBFB and MBFM are absent. At the ILM and Boeing sites, the MBFB is between 20 and 30 feet thick and is the uppermost water-bearing zone.

1.5.1.3 Lower Bellflower Aquitard

The LBF is an overall muddy HSU that is laterally continuous throughout the Dual Site. The transition from the Middle Bellflower to the LBF is sharp to gradational, often marked by shell fragments at the base of the MBFC and underlying bluish to greenish gray muds. The LBF ranges from five feet to 40 feet in thickness at the Dual Site. While overall a muddy unit with aquitard properties, the LBF comprises a complex, heterogeneous interval of layered sediments including an upper mud layer, a middle sand layer, and a lower mud layer. The thicknesses of the respective layers vary and the predominantly sand middle layer is locally discontinuous.

1.5.1.4 Gage Aquifer

The Gage Aquifer underlies the LBF and is the lowest HSU within the Lakewood Formation. The transition from the LBF to the Gage Aquifer is generally gradational with the muddy layers grading into gray or greenish gray, fine to medium-grained sand containing little silt and clay. The Gage Aquifer is laterally continuous beneath the Dual Site and ranges in thickness from 40 to 80 feet. A fossiliferous and gradational layer containing shells with increasing silt content forms a distinctive feature near the base of the unit. No currently active municipal production wells have been identified in the Gage Aquifer within a one-mile radius from the 2015 chlorobenzene/pCBSA plume (AECOM, 2017a).

1.5.2 San Pedro Formation

HSUs underlying the Gage Aquifer are part of the San Pedro Formation and include the Gage-Lynwood Aquitard and the Lynwood Aquifer, which are briefly described below.

1.5.2.1 Gage-Lynwood Aquitard

The Gage-Lynwood Aquitard is an overall muddy HSU, similar in character to the LBF, consisting of interbedded fine-grained sands and muds. The Gage-Lynwood Aquitard is laterally continuous throughout the Dual Site and is between 20 and 45 feet thick.

1.5.2.2 Lynwood Aquifer

The Lynwood Aquifer is composed of laminated, fine- to coarse-grained sands with local gravel beds. The Lynwood Aquifer occurs at depths of approximately 220 feet to 250 feet bgs (CDWR, 1961; Hargis + Associates, 1992) and extends to a depth of approximately 375 feet bgs within the Dual Site (CDWR, 1961).

While Dual Site investigations have not penetrated below the Lynwood Aquifer, underlying units are known to include the Lynwood-Silverado Aquitard and the Silverado Aquifer. The Silverado Aquifer is known to be utilized by municipal production wells, but no currently active municipal production wells have been identified within a one-mile radius from the 2015 chlorobenzene/pCBSA plume (AECOM, 2017a).

1.6 CHEMICALS OF CONCERN

The driving groundwater chemicals for the Dual Site are identified in the ROD as benzene, chlorobenzene, TCE, and PCE (see ROD Part II, Section 7.1). For the purposes of this report, the distributions of chloroform, pCBSA, and TBA are also evaluated. Benzene, chlorobenzene, TCE, PCE, and TBA are collectively referred to in this report as “key VOCs.” The complete list of detected chemicals for which the ROD established ISGS comprises 63 compounds, including both VOCs and pesticides (USEPA, 1999).

The current distribution of key VOCs and pCBSA is presented in Section 3.3.

1.7 SOURCE AREAS

Potential groundwater contamination sources identified in the vicinity of the Dual Site are summarized on Figure 9. Due to an incomplete knowledge of the ownership and operational histories at some properties, the facilities identified on the figure may not in every case correspond with the responsible party, and the current status of groundwater investigations at some facilities is unknown. NAPL is known to be present at the Montrose and Del Amo sites. Several NAPL areas not associated with either the Montrose or Del Amo sites are also shown:

- Three areas adjacent to petroleum transmission pipelines,
- An area at the Honeywell Site, and
- Several areas at the PBF Site.

1.8 POTENTIAL MIGRATION PATHWAYS AND RECEPTORS

Potential groundwater chemical migration (exposure) pathways include direct contact, ingestion, and vapor inhalation.

- **Direct Contact:** There is very limited potential for direct contact with impacted groundwater associated with the Dual Site due to the depth of the water table (approximately 30 to 65 feet bgs) and the absence of production wells in the vicinity of Dual Site dissolved chemical plumes. Direct contact with groundwater could only occur during drilling and well completion operations, and well sampling events. Procedures are implemented by properly trained personnel to prevent such contact.
- **Ingestion:** There is also very limited potential for ingestion of impacted groundwater associated with the Dual Site due to the depth of the water table and the absence of production wells in the vicinity of Dual Site dissolved chemical plumes. Ingestion of groundwater could only occur during drilling and well completion operations, and well sampling events. Procedures are implemented by properly trained personnel that prevent ingestion. All water for domestic and industrial use in the vicinity of the Dual Site is supplied by the California Water Service Company (formerly the Dominguez Water Company). The nearest downgradient water supply well (CWSC 219-02) is located approximately 1.4 miles southeast of the Dual Site, is screened in the Silverado Aquifer (510 to 680 feet bgs), and is inactive (AECOM, 2017a). This well is approximately 1.2 miles from the downgradient end of the Dual Site chemical plumes. The potential for new supply wells in the area is limited due to previous adjudication of the West Coast Basin, which is managed by the California Department of Water Resources, the court-appointed Watermaster.
- **Vapor Inhalation:** Exposure associated with volatilization from groundwater and subsequent vapor intrusion is unlikely due to the water table depth, the relatively low-permeability soils present above the water table, and biodegradation processes that occur naturally in the shallow subsurface where there is abundant oxygen. Recent findings from USEPA's vapor intrusion investigations in the residential area downgradient of the Dual Site further support a conclusion that vapor intrusion from groundwater impacts associated with the Dual Site is unlikely (November 15, 2016 email from Yarissa Martinez of USEPA).

Human receptors of potential concern for the Dual Site include commercial/industrial workers, residents, and trench (construction) workers.

For the reasons explained above, ingestion and direct contact groundwater exposure pathways are considered incomplete for all workers on the Dual Site. The vapor intrusion pathway is considered potentially complete, but the results of recent investigations did not indicate a vapor intrusion concern.

There is no current residential use at either the Montrose or Del Amo sites, and current zoning prohibits such use. The nearest residential area is located immediately south of the southwestern portion of the Del Amo Site (Figure 2). Further information regarding exposure pathways and receptors is presented in the risk assessment reports for the Del Amo and Montrose sites (Geosyntec and URS, 2006; McLaren Hart, 1998) and in result summaries prepared by USEPA for the recently completed vapor intrusions studies (USEPA, 2016).

Ecological risk assessment studies for the Dual Site have been limited due to its location in a highly developed commercial/industrial/residential area of Los Angeles and the consequential lack of sensitive habitats and special-status species. Receptors of concern identified are limited to the American Kestrel, which has been identified within the Los Angeles Department of Water and Power utility corridor near the southern boundary of the Del Amo Site. Due to the depth of the water table, both direct contact and ingestion exposure pathways are incomplete. Exposure through vapor inhalation is judged to be inconsequential and incomplete because the American Kestrel is highly mobile and does not burrow in soil or reside in confined spaces with reduced air flow. Further details regarding ecological risk assessment are available in Appendix I of the Baseline Risk Assessment for the Del Amo Site (Geosyntec and URS, 2006).

2 GROUNDWATER MONITORING PROGRAM

Initial Montrose Site investigations began in the 1980s and extended through the mid-2000s. For a detailed presentation of extensive historical investigations, please see the Montrose RI (USEPA, 1998) and the completion report on additional data acquisition and model refinement (Hargis + Associates, 2006).

Groundwater investigations at the Del Amo Site began in the 1980s with installation of multiple water table monitoring wells as part of Waste Pits investigations. Groundwater investigations expanded to include the larger Del Amo Site during initial RI work in the 1990s, during which time a site-specific groundwater monitoring program was initiated. The Dual Site OU was created in 1995 by USEPA, although separate Montrose and Del Amo Groundwater RI reports were produced (USEPA, 1998; Dames & Moore, 1998) and groundwater monitoring reports for the two sites continued to be site-specific through 2014. The Groundwater RI for the Del Amo Site includes initial identifications of on- and off-site source areas and NAPL areas. A combined groundwater monitoring and TCE and benzene plumes data acquisition report was issued in 2006 for the Del Amo Site (URS, 2007a) that included findings for multiple installations dedicated to evaluating the extent of the TCE plume. The most recently installed well for the Del Amo Site is SWL0068 near the southeastern corner of the Site, which was completed in 2009 as part of investigation of a known NAPL source area. Hydrogeologic data from groundwater investigations referenced above are included in Appendix Q.

Current groundwater investigations are limited to ongoing annual monitoring for the Dual Site, as further described below.

2.1 SAMPLING AND ANALYTICAL PROGRAM

Ongoing groundwater investigation consists of annual monitoring, which includes concurrent measurement of groundwater levels and collection and analysis of samples from wells installed as part of investigations for the Montrose, Del Amo, Boeing, JCI, and ILM sites, and groundwater level measurements only for the PBF and Honeywell sites. The monitoring well network currently comprises more than 500 monitoring wells. Montrose and Del Amo monitoring wells were included in the 2017 groundwater monitoring event in accordance with an updated Sampling and Analytical Plan (Table 2) that was approved by USEPA in an email dated September 1, 2017 (USEPA, 2017a).

Laboratory analyses completed for Montrose and Del Amo wells included the following:

- VOCs by USEPA Method 8260B;
- pCBSA by USEPA Method 314.0 Modified;
- Biodegradation parameters:
 - Nitrate (NO_3^-) using USEPA Method 300.0;
 - Ferrous iron (Fe^{2+}) using SM3500-FeB;
 - Sulfate (SO_4^{2-}) using USEPA Method 300.0;
 - Total alkalinity using SM2320B;
 - Dissolved methane (CH_4) and carbon dioxide (CO_2) using RSK175(M); and
 - Quantitative Polymerase Chain Reaction (qPCR) Microbial Assay (Benzene Degradation).

The specific analyses completed for each well are indicated in Table 2. Groundwater elevation and laboratory analytical results for the well network provide a comprehensive data set for characterizing groundwater impacts in the vicinity of the Dual Site and monitoring remedy progress. The Del Amo monitoring program includes baseline/5-year review and first semi-annual and subsequent annual groundwater monitoring events. The 2017 groundwater monitoring event is considered to be the final baseline event as functional testing of the TGRS was initiated in December 2017. The Montrose MACP includes baseline, semi-annual, annual, and 5-year monitoring events. Further information regarding the monitoring programs is provided in the MACPs for the Montrose and Del Amo sites (AECOM, 2014; URS, 2014).

2.2 FIELD METHODS AND PARAMETERS

2.2.1 Montrose Wells

Montrose collected groundwater samples using low-flow sampling methods per the MACP (AECOM, 2014) and in compliance with established USEPA protocols (USEPA, 2017c). A low-flow bladder pump, dedicated tubing, and a compressed nitrogen cylinder were used to collect groundwater samples from the approximate middle of the well screen. The pump was positioned approximately in the middle of the well screen, and the well purged at a low flow rate generally between 100 and 200 milliliters (mL) per minute. Fifteen of these wells were purged at a rate of 100 mL per minute in order to prevent excessive drawdown. The water level in the well was gauged during purging to verify that minimal drawdown was occurring. The purge times for wells sampled ranged from approximately 15 to 20 minutes. With the exception of G-02, which had a final drawdown of 0.58 feet, all wells had a drawdown during purging less than 0.33 feet. Recorded Nephelometric turbidity units (NTUs) were all either within 10% for 3 consecutive readings, or were below 5 NTUs prior to sample collection. Groundwater data generated during well purging were recorded on field purge logs, which are presented in Appendix D.

Before and after sampling each well, the stainless-steel components of the sampling equipment were decontaminated utilizing a standard triple-rinse method and non-phosphate detergent, and the disposable bladder and tubing were replaced. Only distilled water was used during decontamination procedures; Site water was not used during any portion of the field operations. Decontamination and purge water was containerized and transferred to the TGRS for processing.

Following purging, groundwater samples were collected directly from the pump tubing into laboratory-supplied sample containers which were filled with no void or trapped air space. Sample containers were labeled, packed in coolers, and transferred to a courier to be transported to Test America Environmental Laboratory under proper chain-of-custody procedures.

2.2.2 Del Amo Wells

Water levels were measured to the nearest hundredth of a foot using an electronic water sounder and recorded on a water level data form. Where present, the depth and thickness of NAPL was measured to the nearest hundredth of a foot using an electric optical interface probe and recorded on a water level data form. Wells containing NAPL were not sampled. Prior to each use, water level meters were washed with deionized water and non-phosphate detergent, followed by a triple rinse with deionized water.

Del Amo wells were purged prior to sampling using either previously installed, dedicated submersible pumps, or a temporary, portable pump that was decontaminated prior to each use by washing with deionized water and non-phosphate detergent, followed by a triple rinse with deionized water. Wells were purged at a rate of between 100 and 400 mL per minute and purging

continued until at least one tubing volume was evacuated and water quality parameters stabilized. Water levels were monitored during purging to verify stabilized drawdown was less than 0.33 feet. Groundwater temperature, pH, specific conductivity, dissolved oxygen (DO), oxidation-reduction potential (ORP), and turbidity were monitored during well purging and were recorded on a field purge log that is presented in Appendix D. Turbidity remained greater than 20 NTUs in two wells despite extended purging efforts during the 2017 monitoring event. Turbidity in well PZL0012 was 90 NTUs after 3 hours and 50 minutes of purging. Turbidity in well SWL0036 was 342 NTUs after 48 minutes of purging.

Purge water was stored in a temporary tank located at the Del Amo Waste Pits OU pending waste profiling to determine appropriate off-site disposal. The purge water was subsequently transported by American Integrated Services as hazardous waste to Evoqua Water Technologies in Vernon, California for treatment and recycling. The waste disposal manifest is provided in Appendix E.

Following purging, groundwater samples were collected using low-flow sampling methods per the Del Amo MACP (URS, 2014), in compliance with established USEPA protocols (USEPA, 1996). Samples were collected using the submersible pump positioned in the middle of the well screen and dedicated tubing, then placed into laboratory-supplied sample containers. Containers were filled to eliminate trapped air space, labeled, packed in coolers, and transferred to a courier for transport to Eurofins Calscience Environmental Laboratory under chain-of-custody procedures.

2.3 OPERATION AND MAINTENANCE

2.3.1 Montrose

Operation and maintenance (O&M) specific to the Montrose Site is limited to inspection and maintenance of MACP monitoring wells. Montrose monitoring wells were inspected during the 2017 groundwater sampling event, and repairs were made to select wells which included well box replacement, well lid bolt replacement, well lid gasket replacement, and/or the replacement of locking expanding caps and keyed padlocks. Well maintenance records are included in Appendix C.

2.3.2 Del Amo

Del Amo O&M activities are limited to inspection and maintenance of MACP monitoring wells. Del Amo monitoring wells were inspected during the 2017 groundwater sampling event. A well maintenance record that indicates which wells require maintenance, when maintenance was completed, or when it is scheduled to be performed, is included in Appendix C.

3 DATA PRESENTATION AND EVALUATION

3.1 GROUNDWATER LEVELS AND FLOW

Groundwater level data for more than 500 wells associated with the Dual Site and the Boeing, ILM, JCI, PBF and Honeywell sites are presented in Table 3. Groundwater extraction wells associated with the Boeing and PBF Sites were operating while water level measurements were being collected. TGRS extraction wells were not operational during the September 2017 groundwater gauging event.

Depths to groundwater were measured from the top of casing at each well and converted to elevations relative to mean sea level (msl) using surveyed reference elevations based on North American Vertical Datum (NAVD) 88. Appendix P documents updated survey data for Dual Site wells previously based on the National Geodetic Vertical Datum 29.

3.1.1 Water Table

The depth to groundwater at water table wells ranged from 27.92 (PZL0007) to 65.33 (P-10) feet below reference elevation. The average groundwater elevation in water table wells measured during the 2017 groundwater monitoring event was approximately 1.26 feet higher than during the 2016 groundwater monitoring event. This average excludes extraction well data. Groundwater elevations (excluding extraction wells) ranged from -2.05 feet msl at SWL0068 to -9.10 feet msl at PZL0025 and are mapped on Figure 10.

There are two groundwater depressions resulting from active groundwater extraction:

- Depressions at EWB003/MW0005 and WCC_07S are due to active pumping at these Boeing extraction wells and consistent with the 2016 MACR.

Anomalous groundwater contours are described below:

- A persistent depression at PZL0007 and a persistent mound at SWL0068, both near the eastern border of the Del Amo Site;
- Depressions at PZL0024/SWL0051 and PZL0025/PZL0019, separated by a mound at PZL0020, along the southern border of the Del Amo Site are generally consistent with the 2016 MACR;
- A depression at SWL0001 near the western border of the Del Amo Site;
- A depression at UBI-02 and a persistent mound at UBA-EW-3/MW-14/ UBA-EW-1/UBE-05 on the Montrose Site; and
- A mound located at SWL0028/SWL0057, south of the Dual Site, is also consistent with the 2016 MACR.

Due to the relatively flat groundwater gradient, minor groundwater elevation differences may appear as anomalies. Groundwater mounding may be the result of infiltration of water from artificial recharge sources, an effect from previous pumping or injection in a well, or possibly leaking water supply, irrigation systems, pipelines and/or sewer pipelines. Anomalous contours may also be due to a change in measuring point elevation from wellhead repair or modification. Additional evaluation, including inspection of wellheads at the above-referenced locations, will be performed in 2018.

The 2017 water table is generally consistent with previous monitoring events. Groundwater flow at the water table varies from easterly to southwesterly over the monitoring network. The gradient is 0.0005 toward the southeast, as measured between wells P-2 and MW-29, and is 0.0003 toward the southwest, as measured between wells SWL0017 and MW-29.

A total of 123 water table wells (including Boeing, Del Amo, ILM and Montrose wells) with submerged screen intervals are indicated on Figures 10, 15, 25, 30, 35, 40, 45 and Table 3. Screen intervals for Del Amo Site wells were targeted to address areas of highest contaminant concentration. Further analyses, presented in a meeting with USEPA, provided multiple lines of evidence that rising water levels alone have not caused the decrease in benzene concentrations. Based on these analyses, the water table wells with submerged screens are representative and appropriate for use in MACR analyses.

The average groundwater flow velocity is calculated as follows:

$$V = K(i)/n$$

Where V = flow velocity

K = hydraulic conductivity = 3.0 feet/day (Dames & Moore, 1998; see also Appendix Q)

i = gradient = 0.0005

n = effective porosity = 0.15 (Dames & Moore, 1998; see also Appendix Q)

= 0.010 feet/day or 3.65 feet/year (0.0005 gradient);

= 0.006 feet/day or 2.19 feet/year (0.0003 gradient)

3.1.2 MBFB

The water table resides within the MBFB in the western portion of the Dual Site and the water table and MBFB are therefore identical in this area. Further, the MBFB and MBFC are merged in the central and eastern portions of the Del Amo Site, as described in Section 1.5.1.2 (see HSU block diagram, Figure 8). Figures presenting MBFB data in this report include a dashed yellow line indicating the eastern extent of the MBFM, with MBFB data shown to the west of the line. This line is primarily based on HSU isopach maps that were presented in the Del Amo Groundwater RI Report (Dames & Moore 1998) and are included in Appendix A. The portion of

the line south of Torrance Boulevard is based on recent evaluation of boring logs for Montrose wells in that area.

The depth to groundwater at MBFB wells ranged from 41.51 (SWL0049) to 65.33 (P-10) feet below reference elevation. The average groundwater elevation in MBFB wells measured during the 2017 groundwater monitoring event was approximately 1.20 feet higher than during the 2016 groundwater monitoring event. This average excludes extraction well data. Groundwater elevations (excluding extraction wells) ranged from -3.53 feet msl at P-27A to -7.09 feet msl at UBI-02, and are mapped on Figure 11.

Groundwater depressions resulting from active groundwater extraction in the MBFB parallel those identified for the water table:

- Depressions at EWB003/MW0005 and WCC_07S are due to active pumping at these Boeing extraction wells and are consistent with the 2016 MACR.

Anomalous groundwater contours are described below:

- A depression at SWL0001 near the western border of the Del Amo Site; and,
- A depression at UBI-02 and a persistent mound at UBA-EW-3/MW-14/UBA-EW-1/UBE-05 on the Montrose Site.

Due to the relatively flat groundwater gradient, minor groundwater elevation differences may appear as anomalies. Groundwater mounding may be the result of infiltration of water from artificial recharge sources, an effect from previous pumping or injection in a well, possibly leaking water supply pipelines, irrigation systems, and/or sewer pipelines. Anomalous contours may also be due to a change in measuring point elevation from wellhead repair or modification. Additional evaluation, including inspection of wellheads at the above-referenced locations, will be performed in 2018.

The horizontal hydraulic gradient across the Dual Site, as measured between wells P-9B and MW-09, is approximately 0.0003 in a southeasterly direction. The southeasterly flow direction is consistent with the direction reported for 2016. The 0.0003 hydraulic gradient is a decrease from the 0.0007 gradient reported in the 2016 MACR (AECOM/de maximis, 2017a).

A total of 85 water table wells in the MBFB (including Boeing, Del Amo, ILM and Montrose wells) with submerged screen intervals are indicated on Figure 11 and Table 3. Screen intervals for Del Amo Site wells were targeted to address areas of highest contaminant concentration. Further analyses, presented in a meeting with USEPA, provided multiple lines of evidence that rising water levels alone have not caused the decrease in benzene concentrations. Based on these analyses, the water table wells in the MBFB with submerged screens are representative and appropriate for use in MACR analyses.

The average flow velocity, calculated using the method outlined above ($K = 20$ feet/day; $n = 0.15$), is approximately 0.035 feet/day or 12.78 feet/year.

3.1.3 MBFC / Merged MBFB/MBFC

For the purposes of this report, MBFC and Merged MBFB/MBFC data are presented collectively on figures along with a dashed yellow demarcation line indicating the eastern extent of the MBFM. MBFC data are shown west of the line and Merged MBFB/MBFC data east of the line.

Depth to groundwater for MBFC / Merged MBFB/MBFC wells ranged from 28.55 (BF-EW-3) to 100.77 (EWC005) feet below reference elevation. The average groundwater elevation in MBFC Merged MBFB/MBFC wells measured during the 2017 groundwater monitoring event was approximately 1.47 feet higher than during the 2016 groundwater monitoring event. This average excludes extraction well data. Groundwater elevations ranged from -3.65 feet msl at P-27B to -9.67 feet msl at BF-36 (excluding active extraction wells) and are mapped on Figure 12.

There are three groundwater depressions resulting from active groundwater extraction:

- Depressions at EWC003, EWC005, and EWC006 are due to active pumping at these Boeing extraction wells and consistent with the 2016 MACR.

Anomalous groundwater contours are described below:

- A depression at BF-05, just west of the Del Amo Site;
- Mounding at well BF-01, just west of the Montrose Site; and
- Mounding at well BF-EW-5 on the Montrose Site.

Due to the relatively flat groundwater gradient, minor groundwater elevation differences may appear as anomalies. Anomalous contours may be due to a change in measuring point elevation from wellhead repair or modification, or may also be attributed to the heterogeneous nature of the Bellflower Aquitard. Additional evaluation, including inspection of wellheads at the above-referenced locations, will be performed in 2018.

The 2017 MBFC / Merged MBFB/C potentiometric surface (Figure 12) is generally consistent with those for previous monitoring events. The horizontal hydraulic gradient across the Dual Site, as measured between wells BL-9B and BF-10, is approximately 0.0004 in a southeasterly direction, consistent with 2016 (AECOM/de maximis, 2017a). The average flow velocity calculated using the method outlined above ($K = 163$ feet/day; $n = 0.15$) is approximately 0.484 feet/day or 176.66 feet/year.

3.1.4 Gage Aquifer

The depth to groundwater in Gage Aquifer wells ranged from 30.21 feet (G-EW-2) to 125.74 feet below reference elevation (EWG001). The groundwater elevation in Gage Aquifer wells measured during the 2017 groundwater monitoring event was approximately 1.13 feet higher than during the 2016 groundwater monitoring event. This average excludes extraction and injection well data, as well as PBF and Honeywell data which are reported for the first time in 2017. Groundwater elevations (excluding active extraction wells) ranged from 2.35 feet msl at PBF-XIII-07R to -34.53 feet msl at G-IW-4 and are mapped on Figure 13.

Due to the density of PBF wells on Figure 13, the PBF well labels and groundwater elevation values have been removed. Figure 13a shows the PBF Site at a larger scale and includes well labels and groundwater elevations.

There are three groundwater depressions resulting from active groundwater extraction:

- Depressions at EWG001 and EWG002 are due to active pumping at these Boeing extraction wells.
- A depression encompassing several monitoring wells and extraction wells is due to active pumping in the southeast corner of the PBF Site.

Anomalous groundwater contours are described below:

- Depressions at G-IW-4 and G-IW-5, separated by a mound at G-IW-2, along the southern border of the Del Amo Site;
- Depressions at G-15 (south of the Montrose Site) and G-EW-4 (south of the Del Amo Site);
- A mound located at G-04, west of the Del Amo Site;
- A mound located at G-EW-5, south of Torrance Blvd; and,
- A mound in the vicinity of wells PBF-A-18R, PBF-A-20R, PBF-A-22R, PBF-XIII-38R and PBFXIII-33R on the PBF Site.

Due to the relatively flat groundwater gradient, minor groundwater elevation differences may appear as anomalies. Anomalous contours may also be due to a change in measuring point elevation from wellhead repair or modification. Additional evaluation, including inspection of wellheads at the above-referenced locations, will be performed in 2018.

The 2017 Gage Aquifer potentiometric surface (Figure 13) is generally consistent with previous monitoring events.

The horizontal hydraulic gradient across the Dual Site, as measured between wells P-1C and SWL0020, is approximately 0.0007 in a southeasterly direction, compared to 0.0005 to the

southeast for the 2016. The average flow velocity calculated using the method outlined above ($K = 31$ feet/day; $n = 0.13$) is approximately 0.158 feet/day or 57.67 feet/year.

An additional horizontal hydraulic gradient measured between wells G-26 and G-32, south of the Dual Site, is approximately 0.0010 in a southeasterly direction. The average flow velocity for this area ($K = 31$ feet/day; $n = 0.13$) is approximately 0.242 feet/day or 88.33 feet/year.

3.1.5 Lynwood Aquifer

The depth to groundwater in the Lynwood Aquifer wells ranged from 56.78 feet below reference elevation at PBF-L-02 to 75.79 feet below reference elevation at PBF-L-04. The average groundwater elevation in Lynwood Aquifer wells measured during the 2017 groundwater monitoring event was approximately 0.36 feet less than during the 2016 groundwater monitoring event. This average excludes PBF data which are reported for the first time in 2017. Groundwater elevations ranged from -3.77 feet msl at PBF-PZ-500 to -17.12 feet msl at LW-03 and are mapped on Figure 14. No groundwater elevation anomalies were identified. The horizontal hydraulic gradient at the Dual Site, as measured between wells PBF-PZ-300 and LW-07, is approximately 0.0022 in an easterly direction. The easterly flow direction is consistent with the 2016 direction, while the gradient has increased from the 2016 value of 0.0003 (AECOM/de maximis, 2017a).

3.1.6 Vertical Gradients

Groundwater level measurements at collocated wells completed in different HSUs were used to evaluate vertical gradients between the water table and the Merged MBFB/MBFC, between the MBFB and MBFC, between the Merged MBFB/MBFC and Gage Aquifer, between the MBFC and Gage Aquifer, and between the Gage Aquifer and the Lynwood Aquifer. The potential for vertical hydraulic gradients was assessed by dividing the difference in groundwater elevations for two collocated wells in different HSUs by the difference in elevation between the top of the screen in the first well and the bottom of the screen in the second well (USEPA, 2017b). Vertical gradient values are presented in the following table, with negative values indicating a potential for downward flow.

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HSUs	Collocated Wells		Potential Vertical Gradient ^{a,b}	Average Potential Vertical Gradient Per HSU
Water Table to Merged MBFB/MBFC	SWL0016	SWL0037	-0.054	-0.038
	SWL0024	SWL0023	-0.048	
	MW-24	BF-15	-0.014	
MBFB to MBFC	MBFB-OW-1	BF-OW-1	0.009	-0.003
	MW-14	BF-07	-0.019	
	MW-27	BF-19	-0.002	
	MW-13	BF-06	-0.006	
	MW-2	BF-9	0.003	
Merged MBFB/MBFC to Gage	BF-15	G-08	-0.04	-0.042
	SWL0010	SWL0025	-0.025	
	SWL0013	SWL0022	-0.064	
	SWL0035	SWL0036	-0.036	
MBFC to Gage	BF-OW-1	G-OW-1	-0.007	-0.031
	BF-07	G-06	-0.03	
	BF-19	G-14	-0.053	
	BF-06	G-05	-0.037	
	BF-21	G-24	-0.047	
	BF-26	G-28	-0.013	
Gage to Lynwood	G-06	LW-06	-0.21	-0.219
	G-14	LW-03	-0.225	
	G-05	LW-02	-0.184	
	G-01	LW-5	-0.145	
	LG-2	LW-1	-0.394	
	G-03	LW-07	-0.156	

Notes:

- a The potential for vertical gradients was assessed as potentiometric surface ratios between HSUs.
- b Whether vertical flow occurs between groundwater-bearing units depends on a number of factors, principally whether the vertical conductivity of the aquitard separating the HSUs will allow for flow to occur between the two groundwater-bearing units.

Potential vertical hydraulic gradients are downward and generally increase with increasing depth, consistent with those reported for 2016 (AECOM/de maximis, 2017a).

3.1.7 Groundwater Level Trends

A long-term trend of rising groundwater levels at the Dual Site began in 1965 (see Section 1.5 and Figure 7) and continues to the present. As discussed in Sections 3.1.1 and 3.1.2, some water table wells included in the 2017 monitoring event have submerged screens due to the rising groundwater levels. These wells are indicated in Table 3 and on figures showing water table wells.

3.2 NAPL

3.2.1 Montrose Site

A dense non-aqueous phase liquid (DNAPL) composed of chlorobenzene and DDT is present at the Montrose site within the UBF. Based on samples collected between 1998 and 2009, the DNAPL is composed of approximately 50 percent chlorobenzene, 50 percent DDT, and less than 1 percent other chemicals including chloroform, 1,4-dichlorobenzene, methyl ethyl ketone, and pCBSA (AECOM, 2013). DNAPL has been definitively detected in the unsaturated zone and saturated UBF, predominantly at depths ranging from approximately 75 to 95 feet bgs. The majority of the observed DNAPL is perched on low permeability silt layers within the UBF.

The possible presence of DNAPL in the saturated UBF occurs over an area of approximately 160,000 square feet and is most predominant within the former CPA at the Montrose Site. DNAPL extends east of the former CPA due to migration along the top of low permeability silt layers in the down-slope direction. DNAPL has historically been recovered from seven UBF wells at the Montrose site including MW-02, UBT-1 through UBT-3, UBE-1, UBE-4, and UBE-5. Mobile DNAPL continues to passively accumulate in several of these wells at the Montrose site and is periodically purged.

MW-02 is the only UBF monitor well within the DNAPL-impacted area that was sampled during the 2017 baseline groundwater monitoring event and serves to characterize this source area. It should be noted that during the baseline 2017 monitoring event, no DNAPL was observed in or recovered from MW-02.

Due to the increase in dissolved phase concentration of chlorobenzene in CMW002 an evaluation of potential DNAPL was conducted. DNAPL was observed in CMW002 in 2017, and was subsequently purged from this well. DNAPL has not reoccurred in this well to date, and ongoing monitoring for DNAPL will continue in this well.

3.2.2 Del Amo Site

As part of the Soil and NAPL RI, a total of 12 groundwater contamination source areas (SA-1 through SA-12) were identified (Figure 58, URS, 2007b). NAPL was present during the 2017 groundwater monitoring event in the following wells:

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Well	HSU	Location	NAPL Thickness (feet)	Composition
SWL0001	Water Table	SA-3	0.15	Mainly benzene
SWL0032	MBFB	SA-3	0.06	Mainly benzene
PZL0019	Water Table	Former Waste Pits	6.85	Benzene and other chemicals consistent with the former waste pits ^a

^a Analytical results from 2014 indicated NAPL in this area contains benzene and other chemicals consistent with impacts from the nearby former waste pits.

In the course of the evaluation process and ongoing site investigation activities, the only groundwater contamination source areas that remain (and were included in the Soil and NAPL ROD) were identified as the following:

Source Area	NAPL Presence	Location	On Figure 9
SA-3	Measured in wells	Western boundary of Del Amo Site	#1
SA-6	Residual, not measured in wells	Southwestern boundary of Del Amo Site	#4
SA-11	Residual, not measured in wells	Southeastern boundary of Del Amo Site	#10
SA-12	Residual, not measured in wells	Eastern boundary of Del Amo Site	#9

Del Amo Site NAPL areas are shown on Figures 9, 30, and 31. Time-series NAPL thickness data for wells at which NAPL accumulations have occurred are presented in Appendix R.

3.2.3 Other NAPL Areas

NAPL accumulations or NAPL-impacted soil in the vicinity of the Dual Site that are not associated with either the Montrose or Del Amo sites include two areas south of the Del Amo Site (sources 16 and 17 on Figure 9) and an additional area southwest of the Montrose Site (source 15 on Figure 9). NAPL in these areas is inferred to be associated with nearby petroleum pipelines. NAPL has also been reported at the PBF and Honeywell sites (sources 25 and 38 on Figure 9), west and northwest of the Dual Site.

3.3 DISSOLVED PLUME DISTRIBUTIONS

Laboratory analytical data from the 2017 groundwater monitoring event are presented in Table 4 (key VOCs) and Table 5 (pCBSA). Comprehensive laboratory reports are provided in Appendix N (compact disc). Historical analytical data is presented in Appendix G. Dissolved plume distribution maps by compound and HSU are provided on Figures 15 through 49, and are discussed

below in Sections 3.3.1 through 3.3.5. Laboratory data presented and evaluated are limited to those for the Dual Site, and the Boeing, JCI, and ILM sites.

3.3.1 Chlorobenzene

Samples collected during the 2017 baseline groundwater monitoring event were analyzed for chlorobenzene by USEPA Method 8260B. The chlorobenzene analytical results for each HSU is summarized and discussed below, and presented in Table 4.

3.3.1.1 Water Table

As discussed previously, the water table and MBFB at the Montrose, ILM, and Boeing sites are hydrogeologically consistent; the MBFC also coincides at certain locations with the water table and the MBFB. This results in duplicate presentation of these data within this report, being shown on the water table (UBF), MBFB, or the MBFC / Merged MBFB/MBFC isoconcentration maps.

Chlorobenzene concentrations in the water table ranged from 0.18 (J) $\mu\text{g/L}$ at SWL0009, to 300,000 $\mu\text{g/L}$ at MW-02. Concentrations that exceeded the ISGS of 70 $\mu\text{g/L}$ were detected in 10 samples collected from locations in the water table. Chlorobenzene results from water table samples are provided in Table 4 and mapped on Figure 15. UBF extraction well data collected throughout 2017 are also presented in Table 4 and Figure 15.

Water table chlorobenzene results from Montrose-owned and Montrose-sampled wells are shown in time series graphs 1 through 11 in Appendix I. (Note: graphs in Appendix I are ordered first by HSU, then numerically.) Six of the monitor wells presented have not contained detectable concentrations of chlorobenzene during the historical period shown. These are: BL-14A, BF-33, ILM_P-22, and MW-21, and MW-30, and MWB029. Decreasing concentration trends of chlorobenzene of two orders of magnitude (OOM) or more are observed in six of the water table monitor wells. The wells with the observed decreasing concentrations trends of chlorobenzene are: MW-05, -07, -09, -10, -11, and -25. The concentration of chlorobenzene in the sample collected from monitor well MW-02 (300,000 $\mu\text{g/L}$) during the 2017 baseline event is within the historical range of chlorobenzene concentrations. This would indicate that the 2016 result of 1,400 $\mu\text{g/L}$ in this well should be considered anomalous. Monitor well MW-02, located within the DNAPL-impacted area, is included to provide information on the dissolved chlorobenzene concentration within that area. The remaining monitor wells show variation over time, with some currently showing non-detectable concentrations.

The overall distribution of chlorobenzene in the water table remains relatively unchanged from the 2014, 2015, and 2016 baseline groundwater monitoring events, and concentrations were generally consistent with recent historical trends and/or within the range of historical results.

3.3.1.2 MBFB

As previously stated, the MBFB at the Montrose, ILM, and Boeing sites is hydrogeologically consistent with the water table and portions of the MBFC. This results in duplicate presentation of some data, being shown in both the MBFB and water table, and MBFB and Merged MBFB/MBFC isoconcentration contour maps.

Chlorobenzene concentrations in the MBFB ranged from 0.31 (J) $\mu\text{g/L}$ at MW-03 to 300,000 $\mu\text{g/L}$ at MW-02. MBFB samples are provided in Table 4 and mapped on Figure 16. MBFB extraction well data collected throughout 2017 are also presented in Table 4 and Figure 16.

MBFB chlorobenzene results from Montrose-owned and Montrose-sampled wells are shown in time series graphs 2 through 10 in Appendix I. Five of the monitor wells presented have not contained detectable concentrations of chlorobenzene during the historical period shown. These wells are: BL-14A, ILM_P-22, MW-21 and MW-30, and MWB029. Decreasing trends in chlorobenzene concentrations of two OOM or more, which had been observed during previous monitoring events in six of the water table monitor wells, have been also confirmed in the 2017 baseline event. These wells are: MW-05, -06, -09, -10, -11, and -25.

3.3.1.3 MBFC / Merged MBFB/MBFC

Chlorobenzene concentrations in the MBFC ranged from 0.36 (J) $\mu\text{g/L}$ at IWC001 to 130,000 $\mu\text{g/L}$ at CMW002. Concentrations exceeding the ISGS of 70 $\mu\text{g/L}$ were reported in 30 sample locations. Chlorobenzene results from MBFC and the Merged MBFB/MBFC samples are provided in Table 4 and mapped on Figure 17. MBFC and the Merged MBFB/MBFC extraction well data collected throughout 2017 are also presented in Table 4 and Figure 17.

MBFC and the Merged MBFB/MBFC chlorobenzene results from Montrose-owned and Montrose-sampled wells are shown in time series graphs 10 through 24 in Appendix I. Thirteen of the monitor wells presented have not contained detectable concentrations of chlorobenzene during the reporting period shown. Decreasing trends in chlorobenzene concentrations of two OOM or more appear are observed in eight of the MBFC and the Merged MBFB/MBFC monitor wells: BF-05, -11, -21, -22, -23, -25, -31, and SWL0058. Conversely, concentrations of chlorobenzene in three wells (CMW002, BF-12, and G-02WC), are observed to exhibit an increasing concentration trend, which has been increasing with each sampling event since 2012. The remaining monitor wells show variation over time, with some currently showing non-detectable concentrations.

The overall distribution of chlorobenzene in the MBFC and Merged MBFB/MBFC remains relatively unchanged from the 2014, 2015, and 2016 baseline groundwater monitoring events, and concentrations were generally consistent with recent historical trends and/or within the range of historical results.

3.3.1.4 Gage Aquifer

Concentrations in the Gage Aquifer ranged from 0.66 µg/L at G-28 to 6,400 µg/L at SWL0034. Concentrations exceeding the ISGS of 70 µg/L were reported in 17 locations. Chlorobenzene results from Gage Aquifer samples are provided in Table 4 and are mapped on Figure 18. Data from Gage Aquifer extraction well samples collected throughout 2017 are also presented in Table 4 and Figure 18.

Gage Aquifer chlorobenzene results from Montrose-owned and Montrose-sampled wells are shown in time series graphs 24 through 35 in Appendix I. Ten of the monitor wells presented have not contained detectable concentrations of chlorobenzene during the historical period shown. A decreasing trend in chlorobenzene concentrations of two OOM or more was observed in G-04. The remaining monitor wells show variation over time, with some currently showing non-detectable concentrations. The overall distribution of chlorobenzene in the Gage Aquifer remains relatively unchanged from the 2014, 2015, and 2016 baseline groundwater monitoring events, and concentrations were generally consistent with recent trends and/or within the range of historical results with the following exceptions:

- The 2017 result from G-02 is similar to the historical range for this well with a reported concentration of 2,600 µg/L, after the reported concentration from the 2016 sampling event of 26 µg/L was observed to be anomalously low concentration. Reported concentrations for 2014 and 2015 sampling events had been 3,400 and 8,100 µg/L, respectively.
- Chlorobenzene was detected above laboratory reporting limits at G-16 for the first time with a concentration of 4.4 µg/L. Well G-16 is located downgradient of the Montrose Site, and this result is lower than those reported in other nearby Gage wells (i.e. G-08, G-13, and G-25).
- The chlorobenzene concentration of 2,000 µg/L at well G-OW-3 was near the highest ever reported result of 2,200 µg/L recorded in 2012.

3.3.1.5 Lynwood Aquifer

Chlorobenzene was detected in six of the seven samples collected from Lynwood Aquifer during the 2017 baseline sampling event. Each detected concentration was below the ISGS of 70 µg/L. Concentrations in the Lynwood Aquifer ranged from 0.33 (J) µg/L at LW-02 to 22 µg/L at LW-01. Chlorobenzene results from Lynwood Aquifer samples are provided in Table 4 and are mapped on Figure 19.

Lynwood Aquifer chlorobenzene results from Montrose-owned and Montrose-sampled wells are shown in time-series graphs 35 through 37 in Appendix I. Concentrations trends in the Lynwood wells generally have not exhibited variability over time. The reported concentration of chlorobenzene in LW-01 increased relative to the previous sampling event, however the

concentration is within the range of historical results. The overall distribution of chlorobenzene in the Lynwood Aquifer remains relatively unchanged from the 2014, 2015, and 2016 baseline groundwater monitoring events. Concentrations of chlorobenzene were generally consistent with previously reported trends and/or within the range of historical results.

3.3.2 pCBSA

Samples collected during the 2017 baseline groundwater monitoring event were analyzed for pCBSA by modified USEPA Method 314.0. The pCBSA analytical results for each HSU is summarized and discussed below, and presented in Table 5.

3.3.2.1 Water Table

pCBSA was detected in water table wells at concentrations that ranged between 7.4 (J) $\mu\text{g/L}$ at MW-22, and 280,000 $\mu\text{g/L}$ at UBA-EW-1. pCBSA results from water table wells are provided in Table 5 and are mapped on Figure 20. Water table extraction well data are also provided in Table 5 and on Figure 20.

Water table pCBSA results from Montrose-owned and Montrose-sampled wells are shown in time series graphs 1 through 11 in Appendix I. Ten of the monitor wells presented have not contained detectable concentrations of pCBSA during the historical period shown. Decreasing trends in pCBSA concentrations of two OOM or more have been observed in five of the 35 water table monitor wells: MW-05, -06, -12, -25, and BF-32A. The remaining monitor wells show variation over time, with some currently showing non-detectable concentrations.

A split sample was collected from well TMW_14 to assess potential northward migration of pCBSA. The reported pCBSA concentration in TMW_14 was 55 $\mu\text{g/L}$.

The overall distribution of pCBSA in the water table remains relatively unchanged from the 2014, 2015, and 2016 baseline monitoring events, and pCBSA concentrations in the water table were generally consistent with recent trends and/or within the range of historical results.

3.3.2.2 MBFB

pCBSA was detected at concentrations that ranged between 7.4 (J) $\mu\text{g/L}$ at MW-22, and 280,000 $\mu\text{g/L}$ at UBA-EW-1. pCBSA results from MBFB wells are provided in Table 5 and are mapped on Figure 21. MBFB extraction well data are also provided in Table 5 and on Figure 21.

MBFB pCBSA results from Montrose-owned and Montrose-sampled wells are shown in time series graphs 2 through 10 in Appendix I. Eight of the monitor wells presented have not contained detectable concentrations of pCBSA during the historical period shown, while three of the monitor wells contained detectable concentrations for the first time during the 2017 event. These wells

(ILM P-10 [15 µg/L], ILM P-22 [32 µg/L], and BL-14A [16 µg/L]) are located upgradient of well MBFB-OW-1 (7,100 µg/L), in an area with limited available historical pCBSA data.

Decreasing trends in pCBSA of two OOM or more are observed in four of the 35 MBFB monitor wells: MW-05, -06, -12, and -25. The remaining monitor wells show variation over time, with some currently showing non-detectable concentrations.

The overall distribution of pCBSA in the MBFB remains relatively unchanged from the 2014, 2015, and 2016 monitoring events, and concentrations in the MBFB were generally consistent with recent trends and/or the range of historical results.

3.3.2.3 MBFC / Merged MBFB/MBFC

pCBSA concentrations detected in the MBFC and the Merged MBFB/MBFC wells ranged from 4.9 (J) µg/L at BF-29 to 390,000 µg/L at BF-09. pCBSA results from MBFC / Merged MBFB/MBFC samples are provided in Table 5, and are mapped on Figure 22. MBFC extraction well data are also provided in Table 5 and on Figure 22.

MBFC pCBSA results from Montrose-owned and Montrose-sampled wells are shown in time series graphs 10 through 24 in Appendix I. Nine of the monitor wells presented have not contained detectable concentrations of pCBSA during the historical period shown. The remaining monitor wells show variation over time, with some currently showing non-detectable concentrations.

The overall distribution of pCBSA in the MBFC / Merged MBFB/MBFC remains relatively unchanged from the 2014, 2015, and 2016 monitoring events, and concentrations in the MBFC were generally consistent with recent trends and/or the range of historical results. The following is a summary discussion of the analytical data:

- The reported result for BF-29 of 4.9 (J) µg/L, was the lowest result recorded to date, and has decreased from the historical high of 7,400 µg/L in 2012.
- Upgradient wells IWC001 and MWC024 were sampled for the first time during the 2017 baseline monitoring event. Sampling was conducted due to the historical presence of pCBSA in wells CMW001 and CMW002, and to assess any additional northward migration of pCBSA. pCBSA was not detected above a laboratory reporting limit of 10 µg/L in IWC001, and the reported sample result from MWC024 was 72 µg/L.

3.3.2.4 Gage Aquifer

Concentrations in the Gage Aquifer monitor wells ranged from 4.3 (J) µg/L at G-32 to 31,000 µg/L at SWL0034. pCBSA results from Gage Aquifer samples are provided in Table 5 and are mapped on Figure 23. Gage Aquifer extraction well data are also provided in Table 5 and on Figure 23.

Gage Aquifer pCBSA results from Montrose-owned and Montrose-sampled wells are shown in time series graphs 24 through 35 in Appendix I. Seven of the monitor wells presented have not contained detectable concentrations of pCBSA during the historical period shown. The remaining monitor wells show variation over time, with some currently showing non-detectable concentrations.

The overall distribution of pCBSA in the Gage Aquifer remains relatively unchanged from the 2014, 2015, and 2016 monitoring events, and with the exceptions discussed below, concentrations in the Gage Aquifer were generally consistent with recent trends and/or the range of historical results. The following is a summary discussion of the analytical data:

- Concentrations of pCBSA in G-02 (7,800 µg/L) continue to remain low relative to the historic high of 29,000 µg/L observed in 2014. Well G-02 is located at the southeast corner of the Montrose property.
- pCBSA remained undetected in LG-01 for the second consecutive sampling event, with a laboratory reporting limit of 10 µg/L. pCBSA was last detected in LG-01 in 2015 at a concentration of 170 µg/L, and the historic high in LG-01 was 26,000 µg/L as reported in 2014.
- G-16 continues to exhibit a general increasing trend in concentrations since pCBSA was first detected above laboratory reporting limits during the 2015 baseline sampling event. The concentration reported during the 2017 baseline event was the highest to date at 250 µg/L.
- The concentration reported in G-17 (220 µg/L) was the lowest recorded value since sampling began in that well in 1991.

3.3.2.5 Lynwood Aquifer

Samples were collected from all seven Lynwood Aquifer monitor wells (LW-01 through LW-07), and pCBSA was detected above laboratory reporting limits in one well, LW-04, at concentration of 330 µg/L. pCBSA results are provided in Table 5 and Lynwood Aquifer concentrations are mapped on Figure 24.

Lynwood Aquifer pCBSA results from Montrose-sampled and Montrose-owned wells are shown in time series graphs 35 through 37 in Appendix I. Three of the monitor wells presented have not contained detectable concentrations of pCBSA during the historical period shown. pCBSA concentrations in the Lynwood Aquifer were generally consistent with historical results.

The overall distribution of pCBSA in the Lynwood Aquifer remains relatively unchanged from the 2014, 2015, and 2016 baseline events.

3.3.3 Chloroform

All samples collected during the 2017 baseline groundwater monitoring event were analyzed for chloroform by modified USEPA Method 8260B. The chloroform analytical results for each HSU is summarized and discussed below, and presented in Table 4.

3.3.3.1 Water Table

Chloroform concentrations in the water table ranged from 0.25 (J) $\mu\text{g/L}$ at MW-30, to 32,000 $\mu\text{g/L}$ at UBA-EW-1. Chloroform results from water table wells are provided in Table 4 and are mapped on Figure 25, including data from water-table extraction wells collected in 2017.

Chloroform results in select water table wells are shown in time series graphs 1 through 11 in Appendix J. Five of the monitor wells presented have not contained detectable concentrations of chloroform during the historical period shown. The remaining monitor wells show variation over time, with some currently showing non-detectable concentrations.

The distribution of chloroform in the water table remains relatively unchanged from the 2014, 2015, and 2016 baseline groundwater monitoring events, and concentrations in the water table were generally consistent with recent trends and/or the range of historically measured results. The following is a summary discussion of the analytical data:

- The reported concentration at MW-02 (23,000 $\mu\text{g/L}$) is within the historical concentration range after the 2016 baseline event anomalous result.
- The reported concentration at MW-03 (8.5 $\mu\text{g/L}$) was the lowest reported value since 2008, and is near the historical low of 2.1 $\mu\text{g/L}$ reported in 1996.

3.3.3.2 MBFB

Chloroform concentrations in the MBFB ranged from 0.25 (J) $\mu\text{g/L}$ at MW-30 to 32,000 $\mu\text{g/L}$ at UBA-EW-1. MBFB sample results are provided in Table 4 and mapped on Figure 26. MBFB extraction well data collected throughout 2017 are also presented in Table 4 and Figure 26.

MBFB chloroform results from select wells are shown in time series graphs 2 through 10 in Appendix J. Three of the monitor wells presented have not contained detectable concentrations of chloroform during the historical period shown.

The distribution of chloroform in the MBFB remains relatively unchanged from the 2014, 2015, and 2016 baseline events, and concentrations in the MBFB were generally consistent with recent trends and/or the range of historically measured results. The following is a summary discussion of the analytical data:

- The reported concentration at MW-02 (23,000 µg/L) is within the historical concentration range after the 2016 baseline event anomalous result.
- The reported concentration at MW-03 (8.5 µg/L) was the lowest reported value since 2008, and is near the historical low of 2.1 µg/L reported in 1996.

3.3.3.3 MBFC / Merged MBFB/MBFC

Chloroform concentrations in the MBFC / Merged MBFB/MBFC ranged from 0.31 (J) µg/L at MWC016, to 6,000 µg/L at BF-09. Chloroform results from MBFC and Merged MBFB/MBFC wells are provided in Table 4 and mapped on Figure 27, and include data from the MBFC extraction wells collected in 2017.

Chloroform concentrations from select MBFC / Merged MBFB/MBFC wells are shown in time series graphs 10 through 24 in Appendix J. Twenty-three of the monitor wells presented have not contained detectable concentrations of chloroform during the historical period shown. The remaining monitor wells show variation over time, with some currently showing non-detectable concentrations.

Distribution of chloroform in the MBFC / Merged MBFB/MBFC remains relatively unchanged from the 2014, 2015, and 2016 baseline groundwater monitoring events, and were generally consistent with recent trends and/or the range of historically measured results. The following is a summary discussion of the analytical data:

- The concentration value at BF-09 (6,000 µg/L) is the highest concentration reported to date for that location. This well continues to exhibit an increasing trend in chloroform concentrations.

3.3.3.4 Gage Aquifer

Chloroform concentrations in the Gage Aquifer ranged from 0.26 (J) µg/L at MWG001G-01 to 0.32 (J) µg/L at MWG004. Chloroform results from Gage Aquifer wells, including extraction wells, are provided in Table 4 and are mapped on Figure 28.

Gage Aquifer chloroform results from select wells are presented in time series graphs 24 through 35 in Appendix J. Thirty-six of the monitor wells presented have not contained detectable concentrations of chloroform during the historical period shown. The remaining monitor wells show variation over time, with some currently showing non-detectable concentrations.

The distribution and overall trend of chloroform concentrations in the Gage Aquifer remains relatively unchanged from the 2014, 2015, and 2016 baseline groundwater monitoring events. Concentrations in individual Gage Aquifer wells were generally consistent with recent trends and/or within the range of historical results.

3.3.3.5 Lynwood Aquifer

Chloroform was detected above the laboratory reporting limit of 0.5 µg/L in one of the seven Lynwood Aquifer wells with a concentration of 0.33 (J) µg/L at LW-01. Chloroform has not been previously reported in samples collected from LW-01.

Chloroform had not been detected above the reporting limit in any of the seven Lynwood Aquifer wells since 1992; chloroform had been previously detected at a concentration of 2 µg/L in wells LW-05 and LW-07 in 1991.

The overall distribution of chloroform in the Lynwood Aquifer remains relatively unchanged from the prior groundwater monitoring events, and concentrations were generally consistent with recent trends and/or within range of historical results. Results are provided in Table 4 and Lynwood Aquifer concentrations are mapped on Figure 29. Concentration-versus-time graphs of chloroform in select wells are presented in Appendix I.

3.3.4 Benzene

The ROD defines the benzene plume as follows:

“Benzene plume refers to the portion of the distribution of benzene in groundwater at the Joint Site that is not commingled with chlorobenzene. Put another way, the benzene plume is that benzene within the Joint Site that lies outside the chlorobenzene plume... Benzene that is commingled with chlorobenzene is not considered to be part of the benzene plume, but is instead part of the chlorobenzene plume.”

The defined benzene plume is limited to the former Del Amo Site and immediate vicinity, and occurs in the water table, MBFB, MBFC / Merged MBFB/MBFC, and the Gage Aquifer. The current benzene distributions for these HSUs are presented on Figures 30 through 34. Maximum benzene concentrations and plume extent occur in the water table, and typically decrease substantially in the deeper HSUs. While benzene originates from multiple source areas at the Del Amo Site, the associated individual plumes readily biodegrade and do not extend downgradient for significant distances. Time-series concentration data show the benzene plume to be diminishing through time with respect to both size and concentration due to natural attenuation, as detailed in Section 3.4. Benzene concentration-versus-time graphs for the 87 Del Amo Site wells analyzed for VOCs in 2017 are presented in Appendix K.

Different colored isoconcentration lines have been used to illustrate the benzene distribution on the figures. Blue isoconcentration lines represent benzene within the ROD-defined benzene plume, referred to here as the Del Amo Site benzene plume. Green isoconcentration lines indicate benzene within the chlorobenzene plume, and brown isoconcentration lines indicate benzene concentrations not associated with the Dual Site.

3.3.4.1 *Water Table*

The water table benzene distribution is presented on Figure 30 and indicates three benzene plumes within the Del Amo Site:

- A plume in the western part of the Del Amo Site with a maximum benzene concentration of 360,000 µg/L at well PZL0020, located near the southern site boundary. Maximum concentrations are inferred to occur in the vicinity of the SA-3, where benzene NAPL is present, as described in Section 3.2.2.
- A plume near the southeastern border of the Del Amo Site in the vicinity of SA-11, with a maximum benzene concentration of 280,000 µg/L at well MW-04HD.
- A plume near the eastern border of the Del Amo Site with a maximum benzene concentration of 160,000 µg/L at well SWL0068, in the vicinity of SA-12. This plume is distinct from the southeastern plume on the basis of the lack of a benzene detection at well MW-02HD.

The Del Amo Site benzene plume shapes and distributions in the water table are generally consistent with the 2016 plumes (AECOM/de maximis, 2017a) and are entirely within the TI Waiver Zone. Benzene concentrations have decreased since the 2016 monitoring event in each of the three plume areas as follows:

- For PZL0020, in the western plume area, benzene has decreased from 510,000 µg/L to 360,000 µg/L;
- For MW-04HD, near the southeastern border of the Del Amo Site, benzene has decreased from 480,000 µg/L to 280,000 µg/L; and
- For SWL0068, in the eastern plume area, benzene has decreased from 200,000 µg/L to 160,000 µg/L.

The water table benzene distribution within the chlorobenzene plume is shown in green on Figure 30 and is located in the vicinity of the Montrose Site. Plumes in this area include:

- An area immediately southwest of JCI with a maximum benzene concentration of 8,900 µg/L at well MW-07; and
- An area at the southeastern corner of the Montrose Site and southwestern corner of the Del Amo Site where maximum concentrations of 1,100, 1,200, and 1,600 µg/L, are present at wells MW-01, MW-14, and MFFB-EW-1, respectively. This plume is merged with the previously identified area centered on well MW-07.

Additional water table benzene plumes not associated with the Dual Site are indicated in brown on Figure 30. They include:

- A plume at the Boeing Site with a maximum concentration of 130 µg/L in well WCC_03S;
- A plume to the west of the Montrose Site, centered on well MBFB-OW-1 with a benzene concentration of 9,000 µg/L;
- A plume within the former Gardena Valley Landfill #4, south of the Del Amo Site, with a maximum benzene concentration of 3.0 µg/L at SWL0042; and,
- A plume south of Torrance Boulevard with a maximum benzene concentration of 50 µg/L at well MW-25.

A total of 123 water table wells (including Boeing, Del Amo, ILM and Montrose wells) with submerged screen intervals are indicated on Figure 30 and Table 3. As discussed in Sections 3.1.1 and 3.1.2, water table wells with submerged screens are representative and appropriate for use in MACR analyses. Historical benzene data for water table wells with submerged screens are included in Appendix G and in graph format in Appendix K.

3.3.4.2 MBFB

The MBFB benzene distribution is presented on Figure 31. As described in Section 1.5.1.2 and shown on Figure 8, the MBFM is absent in the central and eastern portions of the Del Amo Site so that the MBFB and MBFC are merged in this area. Merged MBFB/MBFC data are presented together with MBFC data on Figure 32 and described below in Section 3.3.4.2. For clarity, the Merged MBFB/MBFC benzene distribution is also shown on Figure 31 in the form of grey, isoconcentration “ghost” lines in the vicinity of the demarcation line where the MBFB plume enters the Merged MBFB/MBFC.

The MBFB plume is identical to the water table plume near the western Del Amo Site boundary and further west, and is described in Section 3.3.4.1 above. Maximum concentrations are inferred to occur in the vicinity of the SA-3, where benzene NAPL is present at SWL0032 as described in Section 3.2.2. The Del Amo MBFB benzene plume is entirely within the TI Waiver Zone.

3.3.4.3 MBFC / Merged MBFB/MBFC

The MBFC / Merged MBFB/MBFC benzene distribution is presented on Figure 32 and indicates three benzene plumes within the Del Amo Site:

- West of the demarcation line where the MBFC is segregated from the MBFB, the plume is limited to a small area centered on well SWL0061 with a maximum concentration of 9.5 µg/L.
- East of the demarcation line, in the Merged MBFB/MBFC, the principal, centrally located plume has a maximum concentration of 170,000 µg/L at SWL0048 and is truncated against the demarcation line (the unshown portion of the plume is presented on Figure 31 as part of the MBFB benzene distribution).

- Also east of the demarcation line, a secondary plume occurs in the vicinity of well SWL0060, with a concentration of 51 µg/L.

Benzene concentrations have decreased since the 2016 monitoring event in each of the three plume areas as follows:

- For SWL0061, in the western plume area, benzene has decreased from 29 µg/L to 9.5 µg/L;
- For SWL0048, in the principal central plume area, benzene has decreased from 200,000 µg/L to 170,000 µg/L; and
- For SWL0060, in the eastern plume area, benzene has decreased from 55 µg/L to 51 µg/L.

The ROD is inconsistent with respect to whether the TI Waiver includes the MBFC in the vicinity of well SWL0060. ROD Figure 10-1 showing the extent of the TI Waiver Zone is reproduced in this report as Figure 5, and does not show an MBFC TI Waiver Zone near the southeast corner of the Del Amo Site. However, the ROD text states that *“Even though the presence of NAPL in the MBFC Sand in the benzene and TCE plumes has not been conclusively determined, EPA has extended the TI Waiver Zone to include the MBFC Sand in these plumes because of its location underneath the LNAPL sources”* (USEPA, 1999). For these reasons, two different TI waiver zones are depicted on Figure 32: one that includes the eastern MBFC benzene plume, and one that does not. Based on the ROD text, the fact that the MBFB and MBFC are not distinct HSUs in the vicinity of the eastern plume, and the known presence of a NAPL source area in the vicinity of SWL0060, the TI Waiver Zone is judged to include the MBFC sand in the vicinity of well SWL0060.

Benzene is also present within the chlorobenzene plume, as indicated in green on Figure 32. Benzene concentrations within the chlorobenzene plume tend to be lower than those within the principal Del Amo Site plume. The Del Amo Site plume attenuates quickly with distance from the source area, while the chlorobenzene-contained benzene extends down gradient to the southeast. The maximum benzene concentration within the chlorobenzene-contained benzene plume is 240 µg/L at well CMW002 which is consistent with the 2016 MACR.

A benzene plume is also present at the Boeing Site, with a maximum concentration of 15 µg/L at wells MWC023 and MWC0004. Benzene concentrations in this plume have generally remained stable since the 2016 monitoring event. This plume is not associated with the Dual Site.

3.3.4.4 Gage Aquifer

The 2017 Gage Aquifer benzene distribution is presented on Figure 33. The Del Amo Site benzene plume is limited to the vicinity of well SWL0063 where benzene is present at 180 µg/L. This concentration decreased from the 2016 value of 280 µg/L, and there is an overall trend of decreasing concentration. The plume area has increased to encompass well SWL0036 to the east, where benzene was detected at 2.9 µg/L (0.27 µg/L in 2016, and below laboratory detection limits

prior to that time). The Del Amo Site benzene plume area is outside the ROD-defined TI Waiver Zone.

A chlorobenzene-contained benzene plume is present to the southwest of the SWL0063 benzene plume. As previously described for the MBFC / Merged MBFB/MBFC, benzene concentrations within the chlorobenzene plume tend to be lower relative to the maximum Del Amo Site plume, but the chlorobenzene-contained benzene extends down-gradient to the southeast. The maximum benzene concentration within the principal chlorobenzene-contained benzene plume is 28 µg/L at well G-12.

An additional minor area of benzene is present at the Boeing facility at well MWG001. This plume is not associated with the Dual Site.

3.3.4.5 *Lynwood Aquifer*

Lynwood Aquifer wells sampled for benzene are presented on Figure 34. There were no detections of benzene in the Lynwood Aquifer in 2017.

3.3.5 PCE

Samples collected during the 2017 baseline groundwater monitoring event were analyzed for PCE by USEPA Method 8260B. The PCE analytical results for each HSU is summarized and discussed below, and presented in Table 4.

3.3.5.1 *Water Table*

Detected PCE concentrations in the water table ranged from 0.27 (J) µg/L at MW-19 to 18,000 µg/L at JMWD-02. Concentrations exceeding the ISGS of 5 µg/L were primarily detected in the vicinities of the Montrose, JCI, and ILM properties. PCE results from water table wells, including extraction wells, are provided in Table 4, and are mapped on Figure 35. Figure 35 also includes historical Amoco/Trico PCE data from 2003 for a more complete depiction of the extent of PCE at the Dual Site, however these contours should be considered estimated based on the age of data.

Water table PCE results from Montrose-owned and Montrose-sampled wells are shown in time series graphs 1 through 11 in Appendix L. Ten of the wells presented have not contained detectable concentrations of PCE during the historical period shown. The remaining monitor wells show variation in concentrations over time, with some currently showing non-detectable concentrations.

The overall distribution of PCE in the water table remains relatively unchanged from the 2014, 2015, and 2016 baseline groundwater monitoring events, and concentrations were generally consistent with recent historical trends and/or within the range of historical results.

3.3.5.2 MBFB

Detected PCE concentrations in the MBFB ranged from 0.26 (J) $\mu\text{g/L}$ at TMW_14 to 18,000 $\mu\text{g/L}$ at JMWD-02. PCE results from MBFB samples are provided in Table 4 and mapped on Figure 36. MBFB extraction well data collected throughout 2017 are also presented in Table 4 and Figure 36. Figure 36 also includes historical Amoco/Trico PCE data from 2003 for a more complete depiction of the extent of PCE at the Dual Site, however these contours should be considered estimated based on the age of data.

MBFB PCE results from Montrose-owned and Montrose-sampled wells are shown in time series graphs 2 through 10 in Appendix L. As shown on the time series graphs, six of the wells presented have not contained detectable concentrations of PCE during the historical reporting period. The remaining wells show some variation over time, with some currently showing non-detectable concentrations.

The overall distribution of PCE in the MBFB remains relatively unchanged from the 2014, 2015, and 2016 baseline groundwater monitoring events, and concentrations were generally consistent with recent historical trends and/or within the range of historical results.

3.3.5.3 MBFC / Merged MBFB/MBFC

Detected PCE concentrations in the MBFC / Merged MBFB/MBFC ranged from 0.44 (J) $\mu\text{g/L}$ at SWL0058 to 37 $\mu\text{g/L}$ at SWL0054. PCE results from MBFC and Merged MBFB/MBFC samples are provided in Table 4 and mapped on Figure 37. MBFC and Merged MBFB/MBFC extraction well data collected in 2017 are also presented in Table 4 and Figure 37.

MBFC / Merged MBFB/MBFC PCE results from Montrose-owned and Montrose-sampled wells are shown in time series graphs 10 through 24 in Appendix L. Thirty-five of the monitor wells presented have not contained detectable concentrations of PCE during the historical reporting period. The remaining monitor wells show variation over time within their specific historical ranges, with some currently showing non-detectable concentrations.

The overall distribution of PCE in the MBFC and Merged MBFB/MBFC remains relatively unchanged from the 2014 and 2015 baseline groundwater monitoring events, and concentrations were generally consistent with recent historical trends and/or within the range of historical results.

3.3.5.4 Gage Aquifer

PCE was detected above laboratory reporting limits in three samples collected from G-02 (0.26 [J] $\mu\text{g/L}$), G-03 (0.30 [J] $\mu\text{g/L}$), and SWL0063 (0.52 [J] $\mu\text{g/L}$). PCE results are provided in Table 4 and Gage Aquifer concentrations are mapped on Figure 38.

Gage Aquifer PCE results from Montrose-owned and Montrose-sampled wells are shown in time series graphs 24 through 35 in Appendix L. Thirty-three of the wells presented have not contained detectable concentrations of PCE during the historical reporting period. The remaining monitor wells show variation over time, with some currently showing non-detectable concentrations.

The overall distribution of PCE in the Gage Aquifer remains relatively unchanged from the 2014, 2015, and 2016 baseline groundwater monitoring events, and concentrations were generally consistent with recent historical trends and/or within the range of historical results.

3.3.5.5 *Lynwood Aquifer*

PCE was not detected in any of the seven Lynwood Aquifer monitor wells sampled. This is consistent with historical results and the results from the 2014, 2015, and 2016 baseline events. Results are provided in Table 4 and Lynwood Aquifer concentrations are mapped on Figure 39. Concentration-versus-time graphs of select wells are presented in Appendix L.

The overall distribution of PCE in the Lynwood Aquifer remains unchanged from the 2014, 2015, and 2016 baseline groundwater monitoring events, and concentrations were generally consistent with recent trends and/or within the range of historical results.

3.3.6 TCE

Samples collected during the 2017 baseline groundwater monitoring event were analyzed for TCE by USEPA Method 8260B. The TCE analytical results for each HSU is summarized and discussed below, and presented in Table 4.

3.3.6.1 *Water Table*

TCE concentrations in the water table ranged from 0.25 (J) $\mu\text{g/L}$ at EWB002, to 12,000 $\mu\text{g/L}$ at DAC-P1. TCE results from water table wells are provided in Table 4 and are mapped on Figure 40, including data from water-table extraction wells collected throughout 2017. Figure 40 also includes historical Amoco/Trico TCE data from 2003 for a more complete depiction of the extent of TCE at the Dual Site, however these contours should be considered estimated based on the age of data.

Water table TCE results from Montrose-owned and Montrose-sampled wells are shown in time series graphs 1 through 11 in Appendix L. Twelve wells have not contained detectable concentrations of TCE during the historical reporting period. The remaining monitor wells show variation over time, with some currently showing non-detectable concentrations.

The distribution of TCE in the water table remains relatively unchanged from the 2014, 2015, and 2016 baseline groundwater monitoring events, and concentrations in the water table were generally consistent with recent trends and/or the range of historically measured results.

3.3.6.2 MBFB

TCE concentrations in the MBFB ranged from 0.25 (J) $\mu\text{g/L}$ at EWB002 to 12,000 $\mu\text{g/L}$ at DAC-P1. MBFB sample results are provided in Table 4 and mapped on Figure 41. MBFB extraction well data collected throughout 2017 are also presented in Table 4 and Figure 41. Figure 41 also includes historical Amoco/Trico TCE data from 2003 for a more complete depiction of the extent of TCE at the Dual Site, however these contours should be considered estimated based on the age of data.

MBFB TCE results from Montrose-owned and Montrose-sampled wells are shown in time series graphs 2 through 10 in Appendix L. Ten of the wells presented have not contained detectable concentrations of TCE during the historical reporting period. The remaining monitor wells show variation over time, with some currently showing non-detectable concentrations.

The distribution of TCE in the MBFB remains relatively unchanged from the 2014, 2015, and baseline groundwater monitoring events, and concentrations in the water table were generally consistent with recent trends and/or the range of historically measured results.

3.3.6.3 MBFC / Merged MBFB/MBFC

Detected TCE concentrations in the MBFC and Merged MBFB/MBFC ranged from 0.51 (J) $\mu\text{g/L}$ at IRZCMW003, to 2,000 $\mu\text{g/L}$ at MWC024. TCE results from MBFC and Merged MBFB/MBFC wells are provided in Table 4 and mapped on Figure 42, including data from MBFC extraction wells collected throughout 2017.

MBFC and Merged MBFB/MBFC TCE results from Montrose-owned and Montrose-sampled wells are shown in time series graphs 10 through 24 in Appendix L. Twenty-eight of the monitor wells presented have not contained detectable concentrations of TCE during the historical reporting period.

TCE was detected above laboratory reporting limits for the first time at well SWL0056 with a concentration of 5.7 $\mu\text{g/L}$. SWL0056 is located to the southeast of the Del Amo Site, outside of the TI Waiver Zone boundary. The remaining monitor wells show variation over time, with some currently showing non-detectable concentrations. Distribution of TCE in the MBFC and Merged MBFB/MBFC remains relatively unchanged from the 2014, 2015, and 2016 baseline groundwater monitoring events, and concentrations were generally consistent with recent trends and/or the range of historically measured results.

3.3.6.4 Gage Aquifer

Detected TCE concentrations in Gage Aquifer wells ranged from 0.27 (J) µg/L at G-14 to 720 µg/L at EWG002. TCE results from Gage Aquifer wells, including extraction wells, are provided in Table 4 and are mapped on Figure 43.

Gage Aquifer TCE results from Montrose-owned and Montrose-sampled wells are shown in time series graphs 24 through 35 in Appendix L. Twenty-six of the monitor wells presented have not contained detectable concentrations of TCE during the historical reporting period. With the exceptions discussed below, the remaining monitor wells show variation over time, with some currently showing non-detectable concentrations.

TCE was detected above laboratory reporting limits for the first time in samples from wells BL-14C and G-02 with concentrations of 1.4 µg/L and 0.35 (J) µg/L respectively. BL-14C is located to the south of the ILM Site, adjacent to TGRS injection wells G-IW-3 and G-IW-7. G-02 is located at the southeastern corner of the Montrose Site, within the TI Waiver Zone boundary.

Distribution of TCE in the Gage Aquifer remains relatively unchanged from the 2014, 2015, and 2016 baseline groundwater monitoring events, and concentrations were generally consistent with recent trends and/or within the range of historically measured results.

3.3.6.5 Lynwood Aquifer

TCE concentrations were not reported detected in any of the samples from any of the monitor wells in the Lynwood Aquifer, with an analytical reporting limit of 0.5 µg/L for all samples. Results are provided in Table 4 and Lynwood Aquifer concentrations are mapped on Figure 44. Concentration-versus-time graphs of select wells are presented in Appendix L.

3.3.7 TBA

Pursuant to direction from USEPA, TBA results and distribution figures have been incorporated into the 2017 MACR. TBA distributions for the different HSUs are provided on Figures 45 through 49 and discussed below. TBA is not a ROD-identified COC for the Dual Site, and no associated ISGS has been established. Therefore, evaluation of the TBA plume with respect to the TI Waiver Zone is not presented.

3.3.7.1 Water Table

The distribution of TBA in the water table is presented on Figure 45, which shows four TBA plumes.

- The principal TBA plume is located near the southeast corner of the Del Amo Site, with maximum concentrations occurring at PZL0026 (39,000 µg/L) and SWL0068 (38,000 µg/L). These concentrations are similar or identical to those for the 2016 monitoring event.
- A plume located along the southern boundary of the Del Amo Site consists of a single detection of 28 µg/L in well SWL0008, similar to the 2016 detection of 25 µg/L.
- A plume is present near the southwest corner of the Del Amo Site near MW-13 (220 µg/L). Concentrations were generally similar to the 2016 event, although in some cases, comparison is not possible due to elevated detection limits.
- A plume is present at the Boeing Site, with maximum concentrations near well MWB006 (270 µg/L). Concentrations were generally similar to the 2016 event, although in some cases, comparison is not possible due to elevated detection limits.

3.3.7.2 MBFB

The distribution of TBA in the MBFB is presented on Figure 46. The water table and MBFB plumes are identical for the area near the western Del Amo Site boundary and further west, and are not discussed further here. The MBFB merges into the Merged MBFB/MBFC east of the orange demarcation line on the figure, and the TBA distribution in this area is shown on Figure 47.

3.3.7.3 MBFC / Merged MBFB/MBFC

The distribution of TBA in the MBFC / Merged MBFB/MBFC is presented on Figure 47. Two plumes are present within the Del Amo Site, one centered on well SWL0055 with a concentration of 360 µg/L, and the other centered on well SWL0060 with a maximum concentration of 35,000 µg/L. These concentrations are similar to those in the 2016 monitoring event.

3.3.7.4 Gage Aquifer

Gage Aquifer wells sampled for TBA are presented on Figure 48. TBA detections were limited to Boeing well MWG003, with a concentration of 9.9 µg/L.

3.3.7.5 Lynwood Aquifer

Lynwood Aquifer wells sampled for TBA are presented on Figure 49. There were no detections of TBA in the Lynwood Aquifer in 2017.

3.4 BENZENE BIODEGRADATION EVALUATION

Intrinsic biodegradation is defined in the ROD as the chemical breakdown of a contaminant by microorganisms that are native and innate to the existing soil. While acknowledging that “...*there is substantial and significant evidence that significant intrinsic biodegradation of the benzene plume is occurring in the UBF, MBFB Sand, and MBFC Sand*”, and that “...*when all lines of evidence are taken together, the case for reliable intrinsic biodegradation of benzene in the benzene plume is strong*”, the ROD requires periodic confirmation that biodegradation can reliably contain the benzene plume in the UBF and MBFB sand. For this reason, an evaluation of benzene plume biodegradation in the water table, MBFB and Merged MBFB/MBFC units was completed in accordance with the Del Amo Intrinsic Biodegradation Monitoring Workplan (AECOM, 2016). It included evaluation of data for 20 wells along four water table transects (WT-1 through WT-4) and ten wells along one MBFB/ Merged MBFB/ MBFC transect, as indicated on Figures H-6 and H-7 in Appendix H, respectively. These transects and wells were selected to provide data at locations up-gradient of the dissolved benzene plume, within the plume, at the down-gradient fringe of the plume, and down-gradient and/or cross-gradient of the plume. The evaluation was completed through the following tasks:

- Examination of trends in groundwater biodegradation indicator data along the transects;
- Use of microbiological techniques to quantitatively assess groundwater microbes with DNA gene groups associated with aerobic and anaerobic hydrocarbon degradation capabilities; and,
- Calculations and modeling to estimate rate constants for benzene associated with concentration versus time, concentration versus distance, and biodegradation.

Details regarding each of these tasks and results are presented below.

3.4.1 Biodegradation Indicators

Biodegrading microorganisms extract energy by metabolizing hydrocarbons, facilitating the transfer of electrons from the hydrocarbon (an electron donor) to oxidized elements in the environment (electron acceptors). Common electron acceptors in the saturated zone include DO, nitrate (NO_3^-), ferric iron (Fe^{3+}), sulfate (SO_4^{2-}), and carbon dioxide (CO_2). Thus, depleted concentrations of these compounds in hydrocarbon-impacted areas serve as indicators of biodegradation. In some cases, it may be more convenient and/or accurate to measure increased concentrations of the byproducts of the oxidation process rather than decreased concentrations of the electron acceptors or reduced species. For example, instead of measuring decreases in the concentrations of Fe^{3+} or CO_2 , increases in concentrations of Fe^{2+} and methane can be measured, which are equally valid biodegradation indicators.

Not all electron acceptors are necessarily present at a site and environmental conditions will dictate which, if any, biodegradation pathways are active. In general, microorganisms will utilize the most energetically favorable electron acceptors available. DO is typically utilized first, because aerobic respiration is the most energetically favorable metabolic pathway. After DO is depleted, microorganisms begin metabolizing hydrocarbons through anaerobic pathways using (in order of preference): NO_3^- , Fe^{3+} , SO_4^{2-} , and CO_2 . Biodegradation indicators evaluated in this investigation included DO, NO_3^- , Fe^{2+} , SO_4^{2-} , methane, CO_2 , ORP, and total alkalinity. DO data are used in evaluating aerobic biodegradation, while NO_3^- , Fe^{2+} , SO_4^{2-} , and methane data are used in evaluating anaerobic biodegradation. Total alkalinity and CO_2 data are used to evaluate aerobic and anaerobic biodegradation collectively. ORP represents the tendency of a solution to accept or lose electrons, and is thus also an indicator for both aerobic and anaerobic biodegradation. In general, groundwater ORP decreases (becomes more negative) as electron acceptors are consumed and the environment becomes more anaerobic and reducing.

Biodegradation indicator data are included in Table H-1 in Appendix H. Evaluation of the data is achieved through observing patterns in indicator values at mid-plume locations near source areas relative to locations along the plume fringe and outside the plume. Depending upon the specific indicator, mid-plume values consistent with biodegradation may be either higher or lower than for locations outside the plume when biodegradation is occurring. Graphs presenting indicator data for each transect and well, and identifying well positions relative to the plume, are presented on Figures H-1 through H-5 in Appendix H. A simplified data summary is presented in the table below with “X” denoting a strong indication (the expected change is observed at all locations), “O” denoting a weaker indication (the expected change is observed at some locations), and a dash (-) indicating the data are not consistent with biodegradation for that pathway.

Biodegradation Type	Indicator	Mid-plume vs. Outside Plume Value Consistent with Biodegradation	Transects				
			WT-1	WT-2	WT-3	WT-4	MBFB / Merged MBFB/MBFC
Aerobic	DO	Decreased	X	O	O	—	X
Anaerobic	Fe^{2+}	Increased	X	X	O	X	X
	Methane	Increased	X	O	X	X	X
	NO_3^-	Decreased	X	X	X	X	X
	SO_4^{2-}	Decreased	X	X	X	X	X
Aerobic and Anaerobic	ORP	Decreased	O	X	X	X	X
	Alkalinity	Increased	X	X	X	X	X
	CO_2	Increased	X	X	X	X	X

As indicated in the graphs and the above table, biodegradation indicator trends overall are consistent with the occurrence of both aerobic and anaerobic biodegradation. This evaluation of biodegradation along transects meets the objective of Section 13, Provision 8.03.06, of the ROD.

3.4.2 Microbiological Data

Microbial Insights, Inc. (Microbial Insights) located in Knoxville, Tennessee was contracted to perform CENSUS analyses on groundwater samples from wells along each biodegradation transect. CENSUS is a polymerase chain reaction (qPCR) procedure that determines the number of copies of targeted gene groups in DNA present in a sample. The targeted gene group count is proportional to the number of cells (microbes) associated with those genes. In this case, the targeted genes were specific to biodegradation of benzene and other aromatic compounds, and gene group counts are equivalent to cell counts (1:1). The CENSUS method avoids the limitations and potential errors of conventional microbiological test methods by eliminating the need to grow microorganisms in the laboratory, and provides an independent line of biodegradation evidence from the indicator compound trends discussed in Section 3.4.1.

The following gene groups associated with biodegradation of aromatic organic compounds were evaluated through the CENSUS analyses:

Environment	Gene Group
Aerobic	RMO
	RDEG
	PHE
Anaerobic	abcA

CENSUS data evaluated in this report include results previously reported in the 2016 MACR as well as 2017 results for six additional wells added to the transects in accordance with the Revised Intrinsic Biodegradation Workplan (AECOM, 2016a). The six new wells have been incorporated into the transects as follows, with some wells being associated with more than one transect:

Transect	Well
WT-1	PZL0016
	MW-27
WT-2	MW-12
	MW-30

Transect	Well
WT-3	SWL0005
	SWL0057
MBFB / Merged MBFB/MBFC	MW-12
	MW-27
	MW-30

The combined 2016 and 2017 CENSUS data are summarized in Table H-2 in Appendix H. Graphs presenting CENSUS results for each transect and well position relative to the benzene plume are presented on Figures H-8 through H-12 in Appendix H, and scatter plots of gene group counts versus benzene concentrations are presented on Figure H-13 in Appendix H. For those wells with 2016 CENSUS data, the data are plotted against 2016 rather than 2017 benzene concentrations so that there is no mixing of data from different monitoring events.

The data, graphs and scatter plots collectively demonstrate that:

- Gene groups and microbes associated with both aerobic and anaerobic benzene biodegradation are present within the benzene plume at the site;
- Aerobic biodegradation gene groups and their associated microbes outnumber anaerobic gene groups in samples from most wells, consistent with research literature findings that aerobic biodegradation generally occurs at a faster rate than anaerobic degradation;
- For the 15 cases where aerobic biodegradation gene group data are available (3 aerobic gene groups times 5 transects = 15 cases), maximum biodegradation gene group counts occurred within the benzene plume (mid-plume or at the edge of the plume) 12 times.
- For the single anaerobic gene group, the maximum gene group count occurred within the benzene plume for 4 of the 5 cases (1 anaerobic gene group times 5 transects = 5 cases); and,
- There is a statistical correlation between benzene concentration and biodegradation gene group counts for each of the aerobic gene groups ($R^2=0.48 - 0.72$). No correlation was evident for the anaerobic gene group data.

Based on the above findings, there is strong microbial DNA evidence that both aerobic and anaerobic biodegradation of benzene is occurring at the site. Microbes capable of degrading aromatic VOCs are present along each of the transects evaluated, with maximum microbe counts occurring either mid-plume or at the edge of the plume in 16 of 20 cases (80 percent; 5 transects times 4 gene groups = 20 cases).

3.4.3 Attenuation Rate Constants

Concentration versus time, concentration versus distance, and biodegradation rate constants were evaluated for groundwater benzene concentrations, as further described below.

3.4.3.1 Concentration versus Time Rate Constants

Concentration versus time rate constants (k_{point}) describe the rate of decrease in benzene concentrations with time and are used for estimating how quickly remediation goals will be met. Benzene concentration through time trends and associated concentration rate constants were calculated for each transect monitoring well using both Mann-Kendall and linear regression statistical techniques.

Mann-Kendall is a non-parametric statistical procedure (Gilbert, 1987) and was implemented using Groundwater Spatio-Temporal Data Analysis Tool (GWSDAT) software. Mann-Kendall does not require any assumptions regarding the statistical distribution of the data and can be used with data sets that are gathered at irregular sample intervals and that may be missing data. The strength of a trend is directly proportional to the Mann-Kendall Statistic, with the sign of the trend indicating whether the trend is increasing (+) or decreasing (-). Statistically significant concentration trends were identified for those cases where the p-value (probability of the trend being due to random variation alone) is less than 0.05 or 5 percent.

Linear regression is a parametric statistical procedure employing a “least-squares” method to identify the first-order slope coefficient that best fits the data, with a higher degree of scatter corresponding to a wider confidence interval for the estimated slope. Benzene concentration data were first log-transformed for this analysis and statistical functions within Microsoft Excel™ were then used to minimize the sum of the squared residuals (or error term) and obtain the slope and y-intercept of the trend line. The standard deviation or standard error of the slope was calculated as well as an F-statistic value to find the degree of confidence in the trend. The calculated slope and desired degree of confidence (95 percent) were used in combination to make a decision regarding the statistical significance of the concentration trend. “No trend” was identified for those locations where the degree of confidence was less than 95 percent.

The Mann-Kendall and linear regression results are presented in detail on Figures H-14 through H-23 in Appendix H, and are summarized in the table below.

Transect	Well ID	2017 Benzene Concentration (µg/L)	Benzene Concentration Trends					
			Mann-Kendall			Linear Regression		
			Trend	Rate Constant (year ⁻¹)	Half-Life (years)	Trend	Rate Constant (year ⁻¹)	Half-Life (years)
WT-1	MW-21	0.86	Decreasing	0.47	1.5	Decreasing	0.47	1.5
	MW-27	0.50 U	Decreasing	0.21	3.3	Decreasing	0.21	3.3
	PZL0016	0.22 J	Decreasing	0.19	3.6	Decreasing	0.19	3.6
	SWL0004	72,000	Decreasing	-	>5	Decreasing	0.14	5
	SWL0038	0.50 U	Decreasing	-	>5	Decreasing	0.074	9.4

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Transect	Well ID	2017 Benzene Concentration (µg/L)	Benzene Concentration Trends					
			Mann-Kendall			Linear Regression		
			Trend	Rate Constant (year ⁻¹)	Half-Life (years)	Trend	Rate Constant (year ⁻¹)	Half-Life (years)
WT-2	MW-12	9.4 J	Decreasing	0.27	2.6	Decreasing	0.27	2.6
	MW-28	18,000	No Trend	-	>5	Decreasing	0.056	12
	MW-30	0.50 U	No Trend	-	>5	No Trend	0.034	20
	SWL0006	0.50 U	No Trend	-	>5	No Trend	0.033	21
	SWL0008	56	Decreasing	0.31	2.3	Decreasing	0.27	2.5
WT-3	MW-04HD	280,000	Decreasing	-	>5	No Trend	-	-
	PZL0012	1.7	No Trend	-	>5	No Trend	0.017	41
	PZL0013	210,000	Decreasing	-	>5	Decreasing	0.023	30
	SWL0005	0.50 U	Decreasing	-	>5	Decreasing	0.1	7.2
	SWL0021	0.47 J	Decreasing	-	>5	Decreasing	0.14	5.1
	SWL0057	0.50 U	Decreasing	-	>5	Decreasing	0.07	9.9
WT-4	PZL0012	1.7	No Trend	-	>5	No Trend	0.017	41
	PZL0026	32	Decreasing	0.21	3.4	Decreasing	0.21	3.4
	SWL0024	0.50 U	Decreasing	-	>5	Decreasing	0.09	7.7
	SWL0046	0.50 U	Decreasing	-	>5	Decreasing	0.084	8.3
	SWL0068	160,000	No Trend	-	N/A	No Trend	0.13	5.3
MBFB / Merged MBFB/ MBFC	G-01WC	0.50 U	No Trend	-	>5	Decreasing	0.12	5.7
	MW-12	9.4 J	Decreasing	0.27	2.6	Decreasing	0.27	2.6
	MW-27	0.50 U	Decreasing	0.21	3.3	Decreasing	0.21	3.3
	MW-28	18,000	No Trend	-	>5	Decreasing	0.056	12
	MW-30	0.50 U	No Trend	-	>5	No Trend	0.034	20
	SWL0037	0.50 U	No Trend	-	>5	No Trend	0.005	140
	SWL0047	0.26 J	No Trend	-	-	No Trend	-	-
	SWL0048	170,000	Increasing/ No Trend ^a	-	N/A	Increasing/ No Trend ^a	-	-
	SWL0050	57,000	No Trend	-	>5	Decreasing	0.088	7.9
	XP-02	0.50 U	No Trend	-	>5	No Trend	0.033	21

^a SWL0048 Mann-Kendall and linear regression trends: increasing from 1995-2004, no trend from 2004-2017.

Statistically significant trends of decreasing benzene concentration through time were identified for 15 of the 26 wells evaluated through Mann-Kendall analysis and for 17 of the 26 wells evaluated through linear regression (wells MW-12, MW-27, MW-28, MW-30, and PZL0012 are

in multiple transects). No trend was identified for 11 wells by Mann-Kendall compared to 8 using linear regression. Monitoring wells where no trend was identified most commonly occur where the data set consists predominantly of non-detect results (wells G-01WC, MW-30, SWL0006, SWL0037, SWL0047, and XP-02) or for wells with high concentrations that are inferred to be located near a source area, (MW-28, SWL0048, SWL0050, and SWL0068).

Trends of increasing concentration were limited to Merged MBFB/MBFC well SWL0048 by Mann-Kendall and linear regression analyses. Mann-Kendall and linear regression results yield no trend in the small 2004 to 2017 dataset. Visual inspection of the SWL0048 benzene data indicates concentrations have been relatively stable since 2004 and decreasing since 2016.

The Mann Kendall and linear regression analyses collectively provide strong evidence for an overall trend of decreasing benzene concentrations through time that are consistent with continued biodegradation of the benzene plume.

3.4.3.2 Concentration Versus Distance Bulk Attenuation Rates

Concentration versus distance bulk attenuation rate constants (k) characterize plume behavior at one point in time with respect to whether it is expanding, shrinking, or showing relatively little change due to the combined effects of dispersion, biodegradation, and other attenuation processes. Transect-specific bulk attenuation rate constants were calculated as follows:

- 2017 benzene concentrations for wells along the intrinsic biodegradation transects were log-transformed;
- The benzene concentration data versus the distance from the source area were plotted for each transect;
- Linear regression statistical analysis was performed using Microsoft Excel™ to derive a best-fit trend line; and
- The bulk attenuation rate constant was calculated as the product of the negative slope of the best-fit trend line and the chemical groundwater velocity, where the chemical groundwater velocity is the groundwater seepage velocity divided by the chemical retardation factor (Newell et al, 2002). Per the Groundwater RI (Dames & Moore, 1998), the benzene retardation factor is approximately 1. The groundwater seepage velocities were calculated based on local transect gradients, as presented below in Section 3.4.3.3.

The monitoring wells, the distances from the source to downgradient monitoring wells, and the benzene concentration inputs for each transect bulk attenuation rate constant estimate are summarized in Table H-3 of Appendix H. The calculated bulk attenuation rates and equivalent half-lives for each transect are summarized in the table below.

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Transect	Wells	Bulk Attenuation Rate (year ⁻¹)	Half-Life (years)
WT-1	MW-21 MW-27 PZL0016 SWL0004	0.13	5.4
WT-2	MW-12 MW-28 MW-30 SWL0006 SWL0008	0.22	3.1
WT-3	MW-04HD PZL0013 SWL0005 SWL0021 SWL0057	0.047	14.9
WT-4	PZL0012 PZL0026 SWL0024 SWL0068	0.46	1.5
MBFB / Merged MBFB/MBFC	G-01WC MW-30 SWL0048 SWL0047 SWL0050 XP-02	0.17	4.0

Half-lives were calculated according to:

$$t = \frac{-\text{LN}[\frac{C_{\text{goal}}}{C_{\text{start}}}]}{k}$$

where:

(C_{goal}/C_{start}) = 0.5; or, -LN(C_{goal}/C_{start})=0.693; and
k = bulk attenuation rate constant (time⁻¹)

The bulk attenuation rates and half-lives estimated above are consistent with a shrinking benzene plume and the continued occurrence of biodegradation.

3.4.3.3 Biodegradation Rate Constants

Biodegradation rate constants (λ) apply to both space and time, and unlike the attenuation rate constants evaluated above, are specific to degradation through biological processes. Biodegradation rate constants were estimated for each transect using BIOSCREEN (USEPA, 1996), a software screening tool for evaluating the potential presence and magnitude of natural attenuation processes, including advection, dispersion, adsorption, and both aerobic and anaerobic (collectively) biodegradation. BIOSCREEN can quantify biodegradation in terms of a rate related to either a chemical concentration or a biochemical indicator parameter, and includes three model types:

- Solute transport without decay;
- Solute transport with biodegradation modeled as a first-order decay process (simple, lumped-parameter approach), and,
- Solute transport with biodegradation modeled as an “instantaneous” biodegradation reaction.

The Domenico analytical solute transport model is used to assess chemical fate and transport under all three model types (Domenico 1987). BIOSCREEN-AT version 1.4.3, developed by S.S. Papadopoulos & Associates, includes USEPA’s BIOSCREEN Version 1.4, and was used for this investigation. Each of the three model types was applied to monitoring well data along each transect. A time interval of 70 years was adopted for analysis, representing an interval from construction of the former Del Amo Site synthetic rubber plant to the present day. This time interval is appropriate in light of the objective of evaluating intrinsic biodegradation of benzene releases associated with the plant site. Future predictive modeling was not undertaken.

The screening model input parameters, transect estimated source area dimensions, transect monitoring wells, estimated centerline distances from the source for each monitoring well, and benzene concentration data are summarized in Table H-5 of Appendix H. Local 2017 hydraulic gradients were used in the models for each water table transect, as follows:

Transect	Hydraulic Gradient	Gradient Basis
WT-1	0.0008	SWL0004 to MW-21
WT-2	0.0052	PZL0020 to SWL0051
WT-3	0.0007	MW-04HD to SWL0021
WT-4	0.0044	SWL0068 to SWL0024
MBFB / Merged MBFB/MBFC	0.0005	SWL0048 to G-01WC

The first-order decay models for each transect were calibrated by iteratively adjusting dispersivity and the biodegradation rate constant until a best fit match was achieved between modeled

concentrations and the 2017 monitoring event concentrations. The resulting models are non-unique solutions, and present one reasonable analytical solution. Calibration of the instantaneous reaction model to the 2017 data was poor or not able to be achieved for the transects, and this model was not used for the evaluation.

Screen captures of the final calibrated BIOSCREEN input and output panels for the transects are provided on Figures H-29a/b through H-33a/b in Appendix H. As indicated there, observed benzene concentrations (black squares on the plots) are consistently lower than concentrations predicted by the no degradation model (red lines on the plots). This finding supports the conclusion that benzene biodegradation is occurring in groundwater at the site.

Estimated first-order benzene biodegradation rate constants and half-lives from the BIOSCREEN modeling are as follows:

Transect	Rate Constant (year ⁻¹)	Half-Life (years)
WT-1	0.15	4.50
WT-2	1.82	0.38
WT-3	0.20	3.40
WT-4	0.48	1.45
MBFB / Merged MBFB/MBFC	0.22	3.10

The rate constants and half-lives estimated above from the BIOSCREEN modeling provide further evidence for the continued occurrence of biodegradation.

3.4.4 Biodegradation Conclusions

Multiple, independent lines of evidence indicate that aerobic and anaerobic biodegradation of benzene continues to occur in the water table and MBFB / Merged MBFB/MBFC units and is sufficient to contain the plume within the TI Waiver Zone at the Del Amo Site. These lines of evidence include:

- Biodegradation indicator data, as well as microbial DNA gene group counts and their correlation with benzene concentrations;
- Statistical analysis indicates trends of decreasing benzene concentrations for numerous individual wells and benzene plumes as a whole, for which rate constants have been estimated; and,
- Modeling through the BIOSCREEN software is also consistent with significant biodegradation, and associated biodegradation rate constants have been estimated.

Since biodegradation of benzene is occurring in the water table and MBFB / Merged MBFB/MBFC units, it is likely or probable that biodegradation of benzene also occurs in the Gage Aquifer.

3.5 QUALITY ASSURANCE/QUALITY CONTROL

Quality assurance/quality control (QA/QC) samples were collected in accordance with each party's respective MACP (AECOM, 2014; URS, 2014) to monitor the effectiveness of the decontamination procedures and to identify any field or laboratory conditions that may have affected sample integrity. Montrose and Del Amo QA/QC samples are discussed below and associated analytical results for all participating parties are summarized in Table 6. A more in-depth discussion of QA/QC findings is presented in the Data Validation Memoranda presented in Appendix M.

3.5.1 Trip Blanks

Laboratory-prepared trip blank samples were placed in each sample cooler that contained more than one VOC groundwater sample. Del Amo submitted 18 and Montrose submitted eight trip blank samples. The trip blank samples were analyzed for VOCs by USEPA Method 8260B. No Del Amo results were qualified based on trip blank results. Five Montrose results were qualified as non-detect for Methylene chloride due to trip blank contamination (Appendix M).

3.5.2 Equipment Blanks

Equipment blank samples were collected to test for potential cross-contamination from the sampling equipment; an equipment blank was collected daily when sampling with a non-dedicated pump. Laboratory-certified water was poured across the decontaminated sampling pump and collected in laboratory-supplied containers. There were 18 equipment blank samples from Del Amo wells and nine from Montrose wells. All equipment blank samples were analyzed for VOCs by USEPA Method 8260B and ten for pCBSA by USEPA Method 314.0 Modified. The equipment blanks were analyzed by the same analytical methodologies as the primary samples. No Del Amo VOC results were qualified based on equipment blank results. The Montrose result for Acetone in MW-19_20170912 was qualified as not detected (U) at the reported value due to equipment blank contamination. No other Montrose VOC results were qualified based on equipment blank results. No pCBSA results were qualified based on equipment blank results.

3.5.3 Duplicate Samples

Field duplicate samples were collected to evaluate sampling and analytical precision. The duplicate set of sample containers was filled immediately following the collection of the corresponding unique sample. Each duplicate sample was handled and analyzed in an identical fashion as the primary samples. There were 11 duplicate samples from Del Amo wells and 11 from Montrose

wells which meets the 10 percent target. All duplicate samples were analyzed for VOCs by USEPA Method 8260B and 10 samples were analyzed for pCBA by USEPA Method 314.0 Modified. As indicated in Section 1.10 of the Del Amo Data Validation Memo (Appendix M-1), and Montrose Superfund Site Data Quality Assessment (Appendix M-2), no results were qualified based on field duplicate results.

3.5.4 Method Blanks

The objective of the method blank analyses is to indicate potential sources of contamination from laboratory procedures. The laboratory prepared and analyzed method blanks samples at the proper frequency for all applicable analyses.

One Del Amo method blank did not detect the target analyte, and as a result, the applicable primary sample results were qualified as not detected above the reported sample quantitation limit (U), as indicated in Section 1.6 of Appendix M-1. No Montrose results were qualified based on method blank results.

3.5.5 Laboratory Control Samples

The objective of laboratory control samples (LCSs) analysis is to evaluate the laboratory accuracy and precision with an interference-free sample. The laboratory prepared and analyzed LCSs at the proper frequency for all applicable analyses.

All LCS recoveries and relative percent differences between the LCS results were evaluated against statistically determined acceptance ranges. Ten LCS and LCS duplicate recoveries and their relative percent differences (RPDs) for Del Amo samples were outside control criteria, and as a result, the applicable primary sample results were qualified as estimated or approximate (J+, UJ), as indicated in Section 1.8 of Appendix M-1. One sample result for acetone was qualified due to LCS recoveries that were outside control criteria, and as a result, the applicable primary sample results were qualified as estimated, as indicated in Appendix M-2.

3.5.6 Matrix Spike/Matrix Spike Duplicates

The objective of the matrix spike/matrix spike duplicate (MS/MSD) analyses is to evaluate the effect of each sample matrix on the sample preparation procedures and the measurement methodology. The laboratory prepared and analyzed MS/MSD samples at the proper frequency for all applicable analyses.

MS/MSD recoveries and relative percent differences between the MS/MSD results were evaluated against statistically determined acceptance ranges. Twenty-two MS/MSD recoveries for Del Amo samples were outside control criteria, and as a result, the applicable primary sample results were qualified as estimated or approximate (J, J+, J-/UJ), as indicated in Section 1.9 of Appendix M-1.

No Montrose sample results were reported outside of MS/MSD recoveries, therefore no samples needed qualification.

3.5.7 Data Validation

3.5.7.1 Data Validation Methodology

Data validation for the 2017 groundwater monitoring event was performed in accordance with each party's respective MACP (AECOM, 2014; URS, 2014). Level IV data packages were submitted for all data. Ten percent of the data were validated in accordance with laboratory specific limits methodology, USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review (USEPA, 2008), and USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review (USEPA, 2014). A lower level QA/QC review was performed on the remaining data. Once data validation was complete, the project database was updated to add the data validation flags and/or other changes.

The data validation qualifications for VOC and pCBA analyses are summarized in the following table:

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Parameter	Analyte	Samples with Qualified Analytical Results	Qualification Rationale
VOC	Tetrachloroethene	GWS02780	LCSs were not within the laboratory's statistically determined acceptance ranges.
	ETBE	GWS02783	
	ETBE	GWS02739, GWS02729 GWS02785, GWS02741 GWS02763, GWS02745	
	DIPE	GWS02803, GWS02800	
	ETBE	GWS02753, GWS02726	MS/MSD results were not within the laboratory's statistically determined acceptance ranges.
	TAME		
	Acetone	GWS02722	
	GRO (C4-C12)	IWS00285, IWS00286	Qualified as not detected (U) at the reported value due to equipment blank contamination
	Acetone	MW-19_20170912	
	tert-Amyl Ethyl Ether	BF11_20170911, SWL0020_20170911, MW-10_20170912, LW-03_20170912, G-14_20170912, BF-19_20170912, G15_20170912, G-21_20170912, EB_2017091201, BF16_20170911	Qualified as estimated (UJ) due to low response in the continuing calibration standard. Results may be biased low or there may be false negatives.
	Methylene chloride	BF-12-20170911, G-18-20170911, G-19A-20170911, MW-25-20170911 MW-22-20170911	Qualified as not detected (U) at the reporting limit due to trip and equipment blank contamination.

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Parameter	Analyte	Samples with Qualified Analytical Results	Qualification Rationale
VOC	2- Butanone	G-03_20170913, BF-02_20170913, G-13_20170913, G-35_20170913, G-09_20170913, SWL0011_20170914, G-OW-3_20170914, MW02_20170914, LW-04_20170914, LW-02_20170914, LW05_20170914, LW-01_20170914, MW06_20170914, MW-13_20170914, G-05_20170914, LG-02_20170914, G-16_20170914, G-12_20170914, G-12_20170914_FD, MW26_20170914, SWL0049_20170914, EB_20170914_01, BF10_20170913, BF-09_20170914, BF-09_20170914_FD, BF09_20170914_FD, EB_20170914_02, EB_20170914_03, TB_20170914_01, TB_20170914_02, BF-35_20170914_FD, BF35_20170914, G-25_20170914, MW-04_20170914,	Qualified as estimated (J, UJ) due to low average relative response factor in the initial calibration.
	Chlorobenzene	BF-09_20170914	Chlorobenzene was qualified as estimated (J) because the concentration exceeded the linear calibration range.
All Compounds	VOCs	BF-15_20170913, MW12_20170912, BF-28_20170912, BF-27_20170912, BF-14_20170913	Qualified as estimated (J, UJ) due to the presence of headspace in the VO vials. Results may be biased low or there may be false negatives

3.5.8 Data Validation Summary

Based on the QA/QC samples and other criteria described in the Data Validation Memoranda, the data, as qualified, are considered valid and useable for the project objectives.

3.5.9 Additional Dilutions

Eurofins was directed to run 2017 groundwater samples at multiple dilutions when feasible to quantify VOCs at reporting limits that are equal to or less than the ISGS, as agreed to in the Response to USEPA Comments, 2016 Baseline MACR (AECOM/de maximis, 2017b). All reporting limits for benzene concentrations provided by Eurofins for Del Amo Site wells were lower than ISGS values (Table 6). Reporting limits for eight Del Amo samples were above the ISGS value of 5 µg/l for PCE and TCE. Eurofins was able to perform additional dilutions on seven of the eight samples and the results are presented in Table O-1 in Appendix O. As indicated in the table, additional dilutions decreased the reporting limit, but not enough to be less than the ISGS value in six of the seven samples. The additional dilution for sample MW-12 was able to reduce the reporting limit from 10 µg/l to 5 µg/l for PCE and TCE.

3.5.10 USEPA Method 8260 Single Ion Method (SIM) Analysis Reporting Limits

Table 9-1, Issue 14 of the First Five Year Review for the Dual Site Groundwater Operable Unit (USEPA, 2015) indicates that reporting limits for one or more key VOCs at some wells are greater than their respective ISGS values, impeding USEPA's ability to assess compliance with the ROD. In 2016, as a trial, groundwater samples from three Del Amo Site wells and three Montrose Site wells were submitted to Test America Laboratory in Irvine, California, for USEPA Method 8260 SIM analysis to evaluate whether lower detection limits could be achieved with this method. In 2017, four additional samples were submitted to Test America for 8260 SIM analysis. Results of the 8260 SIM analysis are presented in Appendix O.

The 2017 8260 SIM analyses did not show a benefit with respect to benzene data, because all benzene data reported by Eurofins for the 2017 groundwater sampling event were below the ISGS value. The analysis showed a benefit for PCE and TCE in sample GWS02708 where the 8260B result was ND<100 µg/l (not detected at the indicated reporting limit) and the 8260 SIM result was 2.6 µg/l. The analysis also showed a benefit for chlorobenzene in sample GWS02708 where the 8260B result was ND<100 µg/l and the 8260 SIM result was ND<0.50 µg/l. The benefit of the 8260 SIM analysis is inconclusive for other key VOCs.

4 CSM UPDATE

Based on 2017 baseline groundwater sampling event, there does not appear to be a spatial distribution trend to the wells with increasing concentration trends, the overall distribution of the various contaminants in the HSUs remains relatively unchanged from the 2014, 2015, and 2016 baseline groundwater monitoring events, and concentrations were generally consistent with recent trends and/or within the range of historical results. Therefore, the current conceptual site model (CSM) remains the same (de maximis/AECOM, 2017). To further define the boundary of the pCBSA plume in the MBFC and Gage Aquifers, and to further understand the nature and extent of pCBSA and other potential contaminants in the Lynwood Aquifer, the installation of additional monitor wells and/or sampling of existing monitor wells owned by Montrose or by other facilities (in-lieu wells) has been proposed by GES and approved by USEPA (GES, 2018; USEPA, 2018). The additional in-lieu and new monitor wells to be added to the Site sampling plan beginning in 2018 are summarized below:

MBFC wells

- AUS-9D (Former Golden Eagle Refinery)
- BF-31 (Montrose)
- BF-32A (Montrose)
- BF-33 (Montrose)
- III-08R (PBF)
- J-MBFC-01 (future JCI well)
- J-MBFC-02 (future JCI well)
- URS-03 (Honeywell)
- VIII-02R (PBF)

Gage wells

- AUS-24D (Gage, Former Golden Eagle Refinery)
- G-38 (proposed new Montrose well)
- GW-4D (Gage, Gardena Valley Landfill)
- GW-6D (Gage, Gardena Valley Landfill)
- VI-06R (Gage, PBF)
- VII-09R (Gage, PBF)

Lynwood wells

- LW-08 (proposed new Montrose well)
- LW-09 (proposed new Montrose well)
- LW-11 (proposed new Montrose well)

Additional detail regarding the location and selection process for each well can be found in the USEPA-approved *Workplan for Additional Wells for pCBSA Data Acquisition* (GES, 2018).

5 CONCLUSIONS

The 2017 groundwater monitoring event was conducted to generate groundwater elevation and laboratory analytical data to evaluate groundwater flow conditions and the extent of Dual Site chemical plumes, and to confirm that the benzene plume is continuing to be contained through intrinsic biodegradation. Findings from the 2017 groundwater monitoring event are summarized below.

5.1 GROUNDWATER LEVELS AND FLOW

Conclusions regarding groundwater levels and flow are as follows:

- Groundwater levels have increased in the water table, MBFB, MBFC / Merged MBFB/MBFC, and Gage Aquifer, continuing the long-term trend of rising groundwater at the Dual Site. The collective average increase for these for these units since the 2016 monitoring event is approximately 1.2 feet.
- Groundwater levels in the Lynwood Aquifer declined slightly for six of the seven Montrose Site wells monitored since 2016. Historical water level data for PBF Site Lynwood Aquifer wells was not available for review.
- The water table groundwater flow direction and horizontal hydraulic gradient remain variable, which is consistent with previous monitoring events.
- The MBFB, MBFC / Merged MBFB/MBFC, and Gage Aquifer groundwater flow directions remain southeasterly, while the gradient in the Lynwood Aquifer remains easterly.
- Potential vertical gradients between HSUs remain downward.

5.2 DISSOLVED PLUME DISTRIBUTIONS

5.2.1 Chlorobenzene

Conclusions regarding chlorobenzene are as follows:

- The overall distribution of chlorobenzene in all HSUs remains relatively unchanged from the 2014, 2015, and 2016 baseline groundwater monitoring events.
- All reported chlorobenzene concentrations in the Lynwood Aquifer were below the ISGS value of 70 µg/L.

5.2.2 pCBSA

Conclusions regarding pCBSA are as follows:

- The overall distribution of pCBSA in all HSUs remains relatively unchanged from the 2014, 2015, and 2016 baseline groundwater monitoring events.
- Additional monitor wells, as identified in Section 4, will be added to the monitoring program beginning in 2018 to increase understanding of the nature and extent of pCBSA in the MBFC, Gage, and Lynwood Aquifers at the Dual Site.

5.2.3 Chloroform

Conclusions regarding chloroform are as follows:

- The overall distribution of chloroform in all HSUs remains relatively unchanged from the 2014, 2015, and 2016 baseline groundwater monitoring events.
- All reported chloroform concentrations in the Gage and Lynwood Aquifers were below the ISGS value of 100 µg/L.

5.2.4 Benzene

Conclusions regarding benzene are as follows:

- ROD-defined benzene plumes in the water table, MBFB, and MBFC / Merged MBFB/MBFC are generally consistent with the 2016 plumes and are entirely within the TI Waiver Zone.
- The ROD-defined benzene plume for the Gage Aquifer is limited to the vicinity of wells SWL0036 (2.9 µg/L) and SWL0063 (180 µg/L) and is outside the TI Waiver Zone. The need for contingent remedial action to address this transgression will be evaluated in a future MACR after the TGRS has begun long-term operation and the impact of the system on the plume can be assessed.
- There were no detections of benzene in the Lynwood Aquifer in 2017.
- Multiple, independent lines of evidence indicate that aerobic and anaerobic biodegradation of benzene continues to occur in the water table and MBFB / Merged MBFB/MBFC units and is sufficient to contain the plume within the TI Waiver Zone at the Del Amo Site. These lines of evidence include biodegradation indicator data, microbial DNA gene group counts and their correlation with benzene concentrations, and statistical- or modeling-based estimates of various benzene attenuation rates. Since biodegradation of benzene is occurring in the water table and MBFB / Merged MBFB/MBFC units, it is likely or probable that biodegradation of benzene also occurs in the Gage Aquifer.

5.2.5 PCE

Conclusions regarding PCE are as follows:

- The overall distribution of PCE in all HSUs remains relatively unchanged from the 2014, 2015, and 2016 baseline groundwater monitoring events.
- PCE was not detected above laboratory reporting limits in any Lynwood Aquifer wells.
- All reported PCE concentrations in the Gage and Lynwood Aquifers were below the ISGS value of 5 µg/L.

5.2.6 TCE

Conclusions regarding TCE are as follows:

- The overall distribution of TCE in all HSUs remains relatively unchanged from the 2014, 2015, and 2016 baseline groundwater monitoring events.
- TCE was not detected above laboratory reporting limits in any Lynwood Aquifer wells.

5.2.7 TBA

Conclusions regarding TBA are as follows:

- Water table TBA plumes are present at three areas within the Dual Site and one area at the Boeing Site and are generally consistent with 2016 plume locations.
- MBFB TBA plumes at the Del Amo Site and the Boeing Site are identical to the water table plumes in these areas. The two plumes remain generally consistent with those for 2016.
- Two MBFC / Merged MBFB/MBFC TBA plumes are present within the Dual Site and remain generally consistent with those for 2016.
- TBA was detected in one Gage Aquifer well at the Boeing Site (MWG003) at a concentration of 9.9 (J) µg/L.
- TBA was not detected in any Lynwood Aquifer wells.

6 RECOMMENDATIONS

6.1 MONTROSE MONITORING NETWORK

6.1.1 Operation and Maintenance

A revised version of the MACP and the Sampling and Analytical Plan is being prepared by Montrose to update the current 2014 version (AECOM, 2014). Continued operation and maintenance of the Montrose monitoring network wells is recommended, in accordance with the 2014 MACP (AECOM) or an updated version, once approved.

6.1.2 Additional Groundwater Monitoring

In order to provide additional data to further understand the nature and extent of pCBSA at the Dual Site, and to monitor the injection of treated groundwater, the Montrose monitoring well network will be expanded. The existing in-lieu monitor wells and new monitor wells identified in Section 4 of this document will be added to the monitoring plan beginning in 2018.

Additional information regarding the selection and location of the additional wells can be found in the USEPA-approved *Workplan for Additional Wells for pCBSA Data Acquisition* (GES, 2018).

6.2 DEL AMO MONITORING NETWORK

6.2.1 Operation and Maintenance

The continued operation and maintenance of the Del Amo Site monitoring network wells is recommended, in accordance with the 2014 MACP (URS) and updated Sampling and Analytical Plan (Table 2). Wells will continue to be inspected during each groundwater sampling event and maintenance will be performed at wells identified in Appendix C. The existing monitoring well network is sufficient to provide the data needed to evaluate groundwater flow directions and the extent of Del Amo Site chemical plumes, and to confirm containment of the benzene plume through intrinsic biodegradation.

6.2.2 Installation of Additional Monitoring Wells

A Groundwater Data Set Refinement Work Plan was submitted to the USEPA in December 2016 (AECOM, 2016b). The work plan presents a scope of work to further characterize soil and groundwater conditions at the Del Amo Site. Activity associated with the work plan will commence upon approval by USEPA.

7 REFERENCES

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